NORTHEAST ELECTRONICS

A DIVISION OF NORTHERN TELECOM, INC.

INSTRUCTION MANUAL

MODEL TTS-26B PULSE SIGNALING TEST SET

No. A0026-20-600 ISSUE 2 DATE SEPT 1971

PRINTED IN U.S.A.

Airport Rd., Concord, N.H. 03301 • (603) 224-6511 • TELEX 94-3453

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SECTION 1

1.1 GENERAL.

1.2 The Model TTS 26B is a compact pulse signaling test set designed to send pulses generated by either a built-in transistorized oscillator or an external source, and to measure the % break and speed of the transmitted pulses, or of pulses received from external sources. The % break of the pulses transmitted by the instrument can be varied over a wide range. The speed of these pulses can be varied in seven discrete steps.

1.3 Signals can be received or transmitted on a loop or an E&M basis. A series of jacks is provided for the proper connection to the particular circuit to be tested. Switches and keys permit the testman to set up testing circuits for different combinations of sending and receiving on the basis of loop, E&M, or a combination of both signaling systems.

1.4 The Model TTS 26B may be used as a pulse repeater or converter. Signals from an external circuit may be applied to the EXT DIAL jack or terminals and used to operate the internal pulsing relay. The % break of this output signal can be varied, and it can be retransmitted on a loop or an E&M basis. It can be used to control external circuits such as voice-frequency signaling circuits, polar duplex circuits, etc.

1.5 Measurements may be made by connecting the high impedance meter circuit to the circuit under test either directly or through a low impedance "slave" relay. The meter slave relay is particularly useful when testing circuits which have high capacitance or inductance. Such circuits might distort the pulse wave shape and thereby result in erroneous meter readings if the high impedance meter were used directly on the circuit under test.

1.6 The meter has two scales - one for measuring % break and the other for pulse speed measurements in pulses per second (PPS). The correct scale is obtained by switching the meter circuit to correspond to the selected mode of operation.

1.7 The TTS 26B may be operated from the 48-volt central office battery or from a suitable substitute such as an NEC PS101. In emergencies a heavy duty 45-volt dry cell will supply adequate power to the instrument for a short time.

1.8 The set is contained in an aluminum carrying case with a removable, hinged cover which includes a storage compartment for cords, small tools, and such items.

1.9 Accessory covers are available to provide additional functions which increase the versatility of the Model TTS 26B. These can be substituted for, or ordered in place of, the removable cover which normally is supplied with the set. A separate description of each of the cover accessories is supplied as supplementary information.

1.10 A relay rack mounted version of the TTS 26B is available in the form of the TTS 26BDR.

SECTION 2

SPECIFICATIONS

2.1 GENERAL.

2.2 Table 2-1 Lists the specifications of the TTS 26B

TABLE 2-1

METER

Ranges

% Break: 0% to 100%
Speed: 0 to 25 pps

Scales

% Break: 1% divisions
Speed : 1 pps divisions

IMPEDANCE OF MEASURING CIRCUITS

Meter Circuit: Approx. 7,500Ω
Meter Relay: Approx. 400Ω

FOR SPEED MEASUREMENTS
Approx. 4,300Ω

SEND SIGNALS

Internal Oscillator: 4,6,8,10,12, 14,20 Pulses/Sec. One additional frequency can be installed on special order.

External Dial: A standard dial or 20 pps dial may be used to generate pulses.

% Break Range: At least 12% to 85%
Transit time <1 millisec.

CONTROLS

1. ADJ % BREAK
2. METER CAL
3. METER CIRCUIT Switch
4. FUNCTION Switch
5. PULSES PER SEC Switch
6. RECEIVE Switch
7. SEND Switch
8. EXT DIAL CIRCUIT Switch
9. SEND and TEST Key Switch
10. TWD-L Key Switch
11. TWD-D Key Switch
12. SEND Turnbutton Switch
13. SPARK SUP Turnbutton Switch
14. DROP E =G&O M =B&O
    DROP E =G&B M =B&O
    Toggle Switch

JACKS

1. EXT DIAL
2. SEND RELAY
3. SEND 1 (LOOP)
4. SEND 2 (LOOP)
5. SEND B&G
6. REC LOOP
7. REC E&M
8. E
9. M
10. LINE
11. DROP
12. 48 Volt S (-) T (+)
13. 48 Volt S (+) T (-)
14. EXT ADAPT (FOR ACCESSORIES)
15. DROP E =G&O M =B&O
    DROP E =G&B M =B&O

SUPERVISORY LAMPS

LINE (E)
DROP (M)

POWER REQUIREMENTS

48 volts DC, ~~220mA~~ 750 ma
Operable from approx. 40V to 55V
Diode protection for polarity reversal.
24 volt DC operation available on special order.
1A feeder ckt required

SIZE

14"w x 10"h x 8"d (includes cover)

WEIGHT

15½ pounds

RACK MOUNTED EQUIPMENT

The Model TTS 26B is also available for bay mounting; it is called Model TTS 26BDR. It includes a telephone dial as well as all the features of the portable set.

Any of the accessories available for the cover of the TTS 26B can be supplied on panels for bay mounting. Ordering information will be supplied on request.

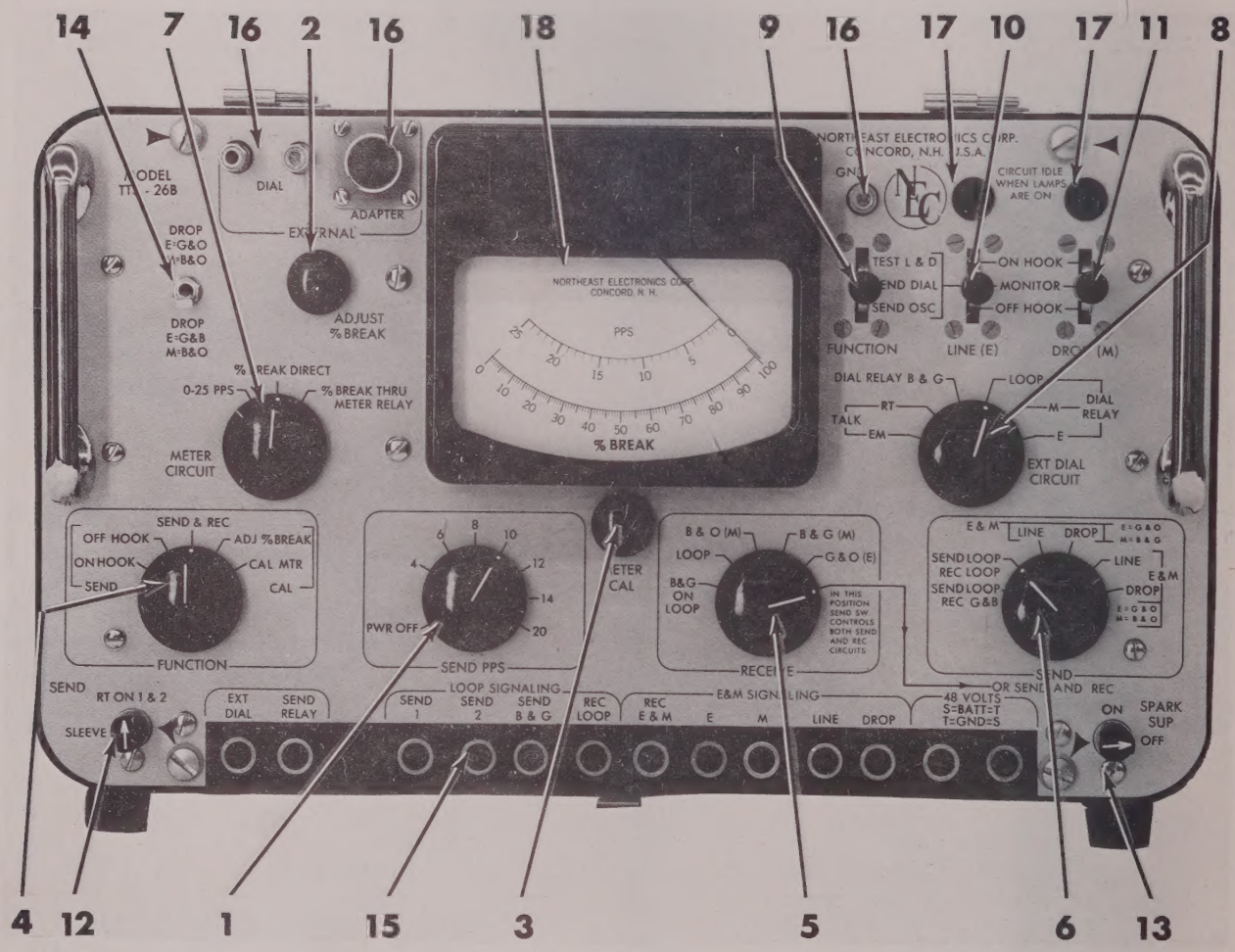


Figure 3-1. Front Panel Controls

SECTION 3

OPERATING INSTRUCTIONS

3.1 GENERAL.

3.2 Table 3-1 lists the functions of all controls and indicators shown indexed on fig. 3-1. Paragraphs 3.3 through 3.19 provide the operating instructions.

TABLE 3-1

Index No.	Control or Indicator	Function
1	SEND PPS	Switch - Provides the following functions: 1. Switches the power on or off. 2. Controls the pulse rate of the internal oscillator for any one of the available seven discrete pulse rates.
2	ADJ % BREAK POTENTIOMETER	Provides the means for adjusting the % break of the transmitted pulses from the internal oscillator or from an external dial.
3	METER CAL POTENTIOMETER	Provides the means for calibrating the meter circuitry.
4	FUNCTION SWITCH	Provides the following functions in clockwise sequence: 1. SEND — a. ON HOOK; b. OFF HOOK 2. SEND AND REC 3. CAL — a. ADJ % BREAK; b. CAL METER
5	RECEIVE Switch	Provides the following receive functions in clockwise sequence: 1. B&G ON LOOP 2. LOOP 3. B&O (M) 4. B&G (M) 5. G&O (E) 6. The final clockwise position permits the SEND or SEND AND REC switch to control both sending and receiving functions, as shown in item 6 following.

TABLE 3-1

Index No.	Control or Indicator	Function
6	SEND or SEND AND RECEIVE switch	Provides the following sending modes in clockwise sequence, when the receive switch is in final clockwise position: 1. SEND LOOP, REC G&B 2. SEND LOOP, REC LOOP 3. E&M LINE B&G on M DROP G&O on E 4. E&M LINE B&O on M (See Note 1) NOTE 1: The E lead status in this mode is controlled by the DROP toggle switch. NOTE: The two SEND LOOP positions provide identical sending conditions; only the receiving functions are different in these positions when this switch is used to control both sending and receiving functions.
7	METER CIRCUIT switch	Provides the following measuring functions in clockwise sequence: 1. 0-25 PPS (Pulse Speed) 2. % BREAK DIRECT 3. % BREAK THRU METER RELAY
8	EXT DIAL CIRCUIT switch	Provides the following modes of operation of the external dial circuit in clockwise sequence: 1. TALK a. EM b. RT 2. DIAL RELAY B&G 3. DIAL RELAY a. LOOP b. M c. E
9	FUNCTION key switch	Provides the following functions: 1. TEST L&D (operated upward) This position disconnects the LINE and DROP, and the E and M jacks from access to other circuits of the set. The LINE (E) and DROP (M) lamp relays are bridged on, and the LINE and DROP jacks are connected together tip to tip and ring to ring. 2. SEND DIAL (position normal) 3. SEND OSC (operated downward)

TABLE 3-1

Index No.	Control or Indicator	Function
10	LINE (E) key switch	Provides for the connection of the following supervisory and measurement functions toward the line: 1. ON HOOK (operated upward) 2. MONITOR (normal position) 3. OFF HOOK (operated downward)
11	DROP (M) key switch	Provides for the connection of the following supervisory and measurement functions toward the line: 1. ON HOOK (operated upward) 2. MONITOR (normal position) 3. OFF HOOK (operated downward)
12	SEND turnbutton switch	Provides the following SEND functions on the LOOP SIGNALING jacks SEND 1 and SEND 2: 1. SEND RT ON 1&2 (operated clockwise) 2. SEND SLEEVES (operated counter clockwise) In normal use this switch should be in the SEND RT ON 1&2 position. The pricipal use for the SEND SLEEVE position is for special applications where direct access to the SEND relay armature, make, and break contacts is desired
13	SPARK SUP turnbutton switch	Inserts an internal spark suppression circuit across the SEND RELAY CONTACTS.
14	DROP toggle switch	Determines the sending status of the E lead, either ground and open or ground and battery.
15	Jacks	The following 310-type jacks are provided from left to right: 1. EXT DIAL (for connecting an external dial, pulsing source, or a telephone set) 2. SEND RELAY (for direct connection to the relay contacts) 3. LOOP SIGNALING - SEND 1 4. LOOP SIGNALING - SEND 2 5. LOOP SIGNALING - SEND B&G 6. LOOP SIGNALING - REC LOOP 7. E AND M SIGNALING - REC E&M

TABLE 3-1

Index No.	Control or Indicator	Function
15 (cont)	Jacks	8. E AND M SIGNALING - E (for connection to the E lead) 9. E AND M SIGNALING - M (for connection to the M lead) 10. E AND M SIGNALING - LINE 11. E AND M SIGNALING - DROP 12. 48 VOLT, S =BATT, T =GND 13. 48 VOLT, S =GND, T =BATT
16	TERMINALS	The following terminals are provided: 1. EXT ADAPT Connector - Provides for connection to accessory covers (Located in upper left of panel). 2. EXT DIAL Binding Posts (2) - Provides for connection of an external dial, source of pulses, or of a telephone set (located in upper left of panel). 3. GND Binding Posts - Provides access to the TTS 26B ground.
17	LAMPS	Two supervisory lamps, designated LINE (E) and DROP (M) are provided to indicate a busy (lamp dark) or idle condition (lamps lighted) on the line and drop circuits to which the set is connected, when E and M supervision is present on the circuits.
18	METER	Provides a display for all measurements.

OPERATING ADDENDUM

The portable version of this instrument has been calibrated with the meter in the horizontal position and the rack-mounted version with the meter in the vertical position. To obtain the specified accuracy, the instrument must be operated in the same position in which it was calibrated. If it is desired to operate the instrument in another position, the instrument must be recalibrated while the meter is in the desired position.

3.3 The different circuits which can be set up under the control of the RECEIVE, and the SEND or SEND AND REC switches are shown in simplified form in figs. 3-2, 3-3 and 3-4. These illustrate the circuits connected to the various jacks for different positions of these switches when the FUNCTION switch is in the SEND AND REC position. These diagrams serve as a quick reference to determine what test connections are being used.

3.4 When the cover of the set has been unlatched and opened it can easily be detached by sliding it to the right. If cords or other items stored in the cover are needed the hinged lid within the cover may be opened by first turning the thumbscrew which serves as the latch.

3.5 CORDS

3.6 Power supply cord - This cord should provide tip and sleeve connections from the set to 48 volts dc (40 to 55 volts). It should have a 310-type plug on the end toward the set. It should be inserted into the set FIRST, and then connected to the power source in order to avoid blowing a fuse when connection is made to the set. For the same reason it should be disconnected from the power source FIRST before it is removed from the set. Power may be obtained from the central office battery or from a NEC PS101 power supply unit or equivalent.

3.7 Sending and receiving test cords - Two - conductor cords (tip and ring) are sufficient for all tests except those special tests requiring direct access to the contacts of the SEND relay, and tests involving sending on the sleeves. For these special tests a 3-conductor cord (tip, ring and sleeve) is needed. All cords should be equipped with a 310-type plug on the end toward the signaling test set.

3.8 Monitoring and Supervisory Lamps. The tip of the E AND M SIGNALING LINE jack in the set is connected to the tip of the DROP jack, and similarly the ring of the LINE jack to the ring of the DROP jack. Hence, when the line and drop jacks of a trunk, on the line side of E and M signaling equipment, are patched to these, the continuity of the trunk is completed through the set. However, it should be noted that during the patching operation an interruption in the continuity of the trunk is caused. This would result in a hit that would be detrimental to any data being transmitted over the trunk, no matter how rapidly the patching operations are made.

3.9 After completion of this patching, when the FUNCTION key is in the TEST L&D position and the LINE (E) and DROP (M) keys are normal (at MONITOR), relays bridging on the tip and ring control the LINE (E) and DROP (M) lamps to indicate whether or not an idle or busy trunk is connected through the LINE and DROP jacks. Thus these lamps will be lighted to indicate idle trunk conditions, or dark to indicate busy conditions.

3.10 A bridging test of % break may be made on an E or M lead. The FUNCTION switch is turned to SEND AND REC, the METER CIRCUIT switch to % BREAK DIRECT (do not use the low impedance THRU METER RLY position), the TEST SEND key is restored to SEND DIAL, and the RECEIVE switch is turned to the appropriate E or M position. When the appropriate E and M SIGNALING - E or M jack in the set is used, and if the trunk under test is in service it is important that the patch to its E or M lead should be bridged only (i.e. should not open the E or M lead of the trunk).

3.11 A further application of this meter monitoring discussed in the preceding paragraph permits an observation of the received % break to be made on the E or M lead while the set is sending on the other of these leads. For this use the FUNCTION key must be in either the SEND DIAL or the SEND OSC position, with the switches involved in sending set at their required positions.

3.12 SENDING SIGNALS WITH A PREDETERMINED % BREAK.

3.13 Fig. 3-3, 3-3a, 3-3b show in simplified schematic form the circuit for sending in each of the sending positions of the SEND or SEND AND REC switch.

3.14 CALIBRATION FOR SENDING % BREAK PULSES. The meter of the TTS 26B must be calibrated for the supply voltage used. When properly calibrated, the set will operate satisfactorily from a stable voltage supply, and the METER CAL control permits calibration of the meter if the supply voltage does not lie outside limits extending from 40 volts to 55 volts.

3.15 SENDING LOOP SIGNALS. The following provides the Procedure for Sending Loop Signals on a Loop Circuit (See fig. 3-3a):

ACTION	RESULT
a. With no power applied to the set, check the position of the meter pointer.	It should be on the 100 line of the % break scale (meter electrical 0). If it is off adjust the screw on the front of the meter case to bring it to this line.
b. After adjustment, back off the adjustment screw slightly to remove mechanical contact between the adjustment screw and the meter mechanism.	This completes the mechanical adjustment of the meter electrical 0.
c. FIRST insert the 310-type plug of the power supply patch cord into the 48 VOLT jack of the set observing that the proper tip and sleeve polarity, and then connect it to the 48-volt dc supply.	If connection is not made in this sequence a battery supply fuse may blow. If the wrong 48-volt jack is used diode protection within the set will protect the set from damage, but the set will be inoperative in succeeding steps.
d. Turn the SEND PPS switch to the desired pulse rate if the internal oscillator is to be used as the source of signals. If a dial or other external source is to be used turn the switch to any position except PWR OFF.	This turns the set on. The LINE (E) and DROP (M) lamps should light. If they do light proceed to step f. If they do not light proceed to step e.
e. If the LINE (E) and DROP (M) lamps do not light remove the dc power supply first, then change the 310-type plug to the other 48 VOLT jack, and reconnect the 48-volt dc power supply.	The lamps should light. If they still do not, the set is probably not receiving power.
f. If the internal oscillator is to be used as the source of pulses, operate the FUNCTION key to SEND OSC. If a dial or other external source or pulses is to be used, restore the FUNCTION key to the SEND DIAL, turn the EXT DIAL CIRCUIT to DIAL RLY-B&G, and connect the external dial or other source of pulsing to the EXT DIAL jack or terminals.	The internal oscillator pulses at the rate determined in step d. If a dial or other external source is to be used a series of zeros must be dialed during the calibration procedure.
g. Turn the FUNCTION switch to CAL METER.	Adjust the METER CAL control to obtain 0 on the % BREAK scale of the meter.
h. Turn the FUNCTION switch to CAL % BREAK.	Adjust the ADJ % BREAK control to the desired % break as indicated on the meter. If the dial is used to generate the signal, dial a series of zeros when adjusting % break.
i. Turn the FUNCTION switch to SEND AND REC.	The set is now ready to send pulses at the required speed and % break. Except for the SEND or SEND AND REC switch, the positions of other switches and keys in the set are immaterial. If the pulse speed is changed the % break calibration should check. The procedure up to this point applies to sending dry pulses on a wet loop, or wet pulses on a dry loop. To send dry pulses on a wet loop proceed with the remaining steps of this paragraph and follow Note 1.

CAUTION

When the TTS 26B is used to pulse repeaters, carrier pulsing units, etc., care should be exercised to simulate the pulsing source in the system under test. In many cases the pulsing source

ACTION	RESULT
will have a spark suppression circuit across the pulsing contacts. Under these conditions, if the spark suppression in the TTS 26B is not used erroneous results will be obtained. If required, turn the SPARK SUP turnbutton to ON, otherwise use it in the OFF position .	steps of this paragraph. If it is desired to send battery and ground, or battery and open on a dry loop, such as into the dry winding of a relay, omit the remaining steps of this paragraph and follow Note 1.
j. Turn the SEND or SEND AND REC switch to either of the SEND LOOP positions. If the SEND LOOP-REC LOOP is used the turnbutton switch in the lower left corner MUST be turned to SEND RT ON 1&2 (its normal position).	It is immaterial which SEND or SEND AND REC position is used unless conditions for receiving measurements also must be controlled. The type of receiving measurements would be controlled if this switch is used to establish both sending and receiving conditions.
k. It is assumed that the loop circuit involved has been turned down to traffic. If it is necessary to dial and talk on the circuit over which pulses are to be sent, connect a telephone set with a dial to the EXT DIAL jack (or terminals) tip and ring with a 310-type plug on the cord.	
l. Turn the EXT DIAL CIRCUIT switch to DIAL RLY - B&G.	
m. Restore the FUNCTION key to SEND DIAL.	
n. Patch the circuit on which dial pulses are to be transmitted to either of the LOOP SIGNALING-SEND 1 or 2 jacks with a 2-or3-conductor cord having a 310-type plug on the end toward the set, using tip and ring conductors.	
o. After dialing on the circuit, it is possible to listen to the ringing and to talk on the circuit by turning the EXT DIAL CIRCUIT switch to TALK EM.	
p. When the circuit is prepared to receive dry contact pulses they may be sent on the circuit from the internal oscillator by operating the FUNCTION key to SEND OSC. To send with the dial of the telephone set or with the dial connected to the EXT DIAL jack or terminals, restore the FUNCTION key to SEND DIAL and turn the EXT DIAL CIRCUIT switch to DIAL RELAY - B&G. This also applies to a dry contact external source connected to the EXT DIAL jack or terminals. If the external source supplies wet contact pulses, the EXT DIAL CIRCUIT switch should be turned to DIAL RELAY-LOOP.	

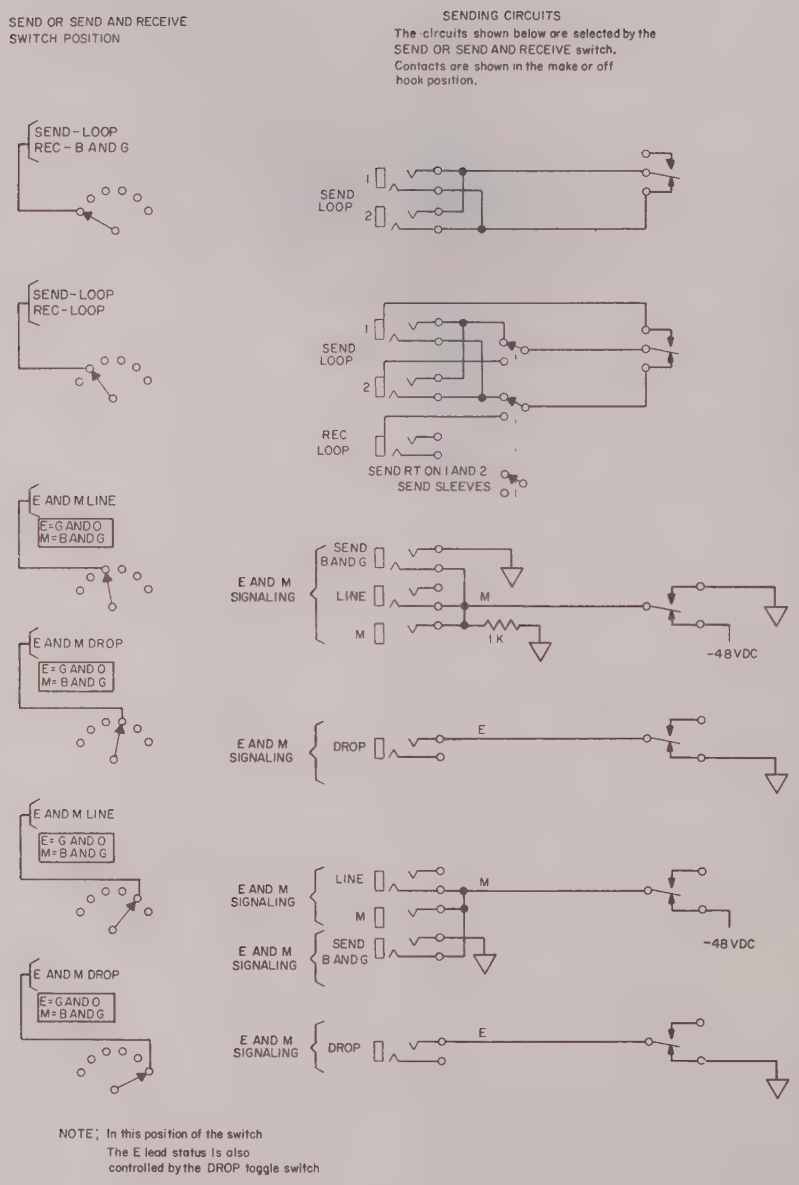

SEND OR SEND AND RECEIVE SWITCH POSITION
SENDING CIRCUITS
The circuits shown below are selected by the SEND OR SEND AND RECEIVE switch. Contacts are shown in the make or off hook position.
SEND - LOOP REC - B AND G
SEND LOOP
1
2
SEND - LOOP REC - LOOP
SEND LOOP
REC LOOP
SEND RT ON 1 AND 2 SEND SLEEVES
E AND M LINE
E = G AND O M = B AND G
E AND M SIGNALING
SEND B AND G
LINE
M
1 K
-48 VDC
E AND M DROP
E = G AND O M = B AND G
DROP
E
E AND M LINE
E = G AND O M = B AND G
E AND M SIGNALING
LINE
M
-48 VDC
E AND M SIGNALING
SEND B AND G
E AND M DROP
E = G AND O M = B AND G
E AND M SIGNALING
DROP
E
NOTE: In this position of the switch The E lead status is also controlled by the DROP toggle switch

Figure 3-2 SEND CIRCUITS

NOTE 1: To send battery and ground, or battery and open on a dry loop, as into the dry winding of a relay, the preceeding is followed through step h. Then (the FUNCTION key being restored to SEND DIAL and the external source being patched to the EXT DIAL jack or terminals) the EXT DIAL CIRCUIT switch should be turned to DIAL RELAY-LOOP, and the SEND or SEND AND REC switch to the E&M - LINE (E =G&O, M =B&G) position for sending battery and ground, or the E&M-LINE (E =G&O, M =B&O) position for sending battery and open. The circuit over which the pulses are to be sent is patched to the LOOP SIGNALING-SEND B&G jack, tip and ring, with a 2- or 3-conductor cord having a 310-type plug on the end toward the set.

3.16 SENDING ON THE E OR M LEAD. The following provides the procedure for Sending Signals on either the E lead or the M lead.

ACTION	RESULT
a. With no power applied to the set, check the position of the meter pointer.	It should be on the 100 line of the % BREAK scale (meter electrical 0). If it is off adjust the screw on the front of the meter case to bring it to this line.
b. After adjustment, back off the adjustment screw slightly to remove mechanical contact between the adjustment screw and the meter mechanism.	This completes the mechanical adjustment of the meter electrical 0.
c. FIRST insert the 310-type plug of the power supply patch cord into the 48 VOLT jack of the set observing the proper tip and sleeve polarity, and then connect it to the 48-volt dc supply.	If connection is not made in this sequence a battery supply fuse may blow. If the wrong 48-volt jack is used diode protection within the set will protect the set from damage, but the set will be inoperative in succeeding steps.
d. Turn the SEND PPS switch to the desired pulse rate if the internal oscillator is to be used as the source of signals. If a dial or other external source is to be used, turn the switch to any position except PWR OFF.	This turns the set on. The LINE (E) and DROP (M) lamps should light. If they do light proceed to step f. If they do not light proceed with step e.
e. If the LINE (E) and DROP (M) lamps did not light remove the dc power supply first, then change the 310-type plug to the other 48 VOLT jack and then reconnect the 48-volt dc power supply.	The lamps should light. If they still do not the set probably is not receiving power.
f. If the internal oscillator is to be used as the source of pulses, operate the FUNCTION key to SEND OSC. If a dial or other external source of pulses is to be used, restore the FUNCTION key to SEND DIAL. Turn the EXT DIAL switch to DIAL RELAY-B&G, and connect the external dial or other source of pulsing to the EXT DIAL jack or terminals, tip and ring.	The internal oscillator pulses at the rate determined in step d. If a dial or other external source is used, a series of zeros must be dialed or the external source must be operated during the calibration procedure.
g. Turn the FUNCTION switch to CAL METER.	Adjust the METER CAL control to obtain 0 on the % BREAK scale of the meter.
h. Turn the FUNCTION switch to CAL % BREAK.	Adjust the ADJ % BREAK control to the desired % break as indicated on the meter, If a dial is used to generate the signal, dial a series of zeros when adjusting to the desired % break.

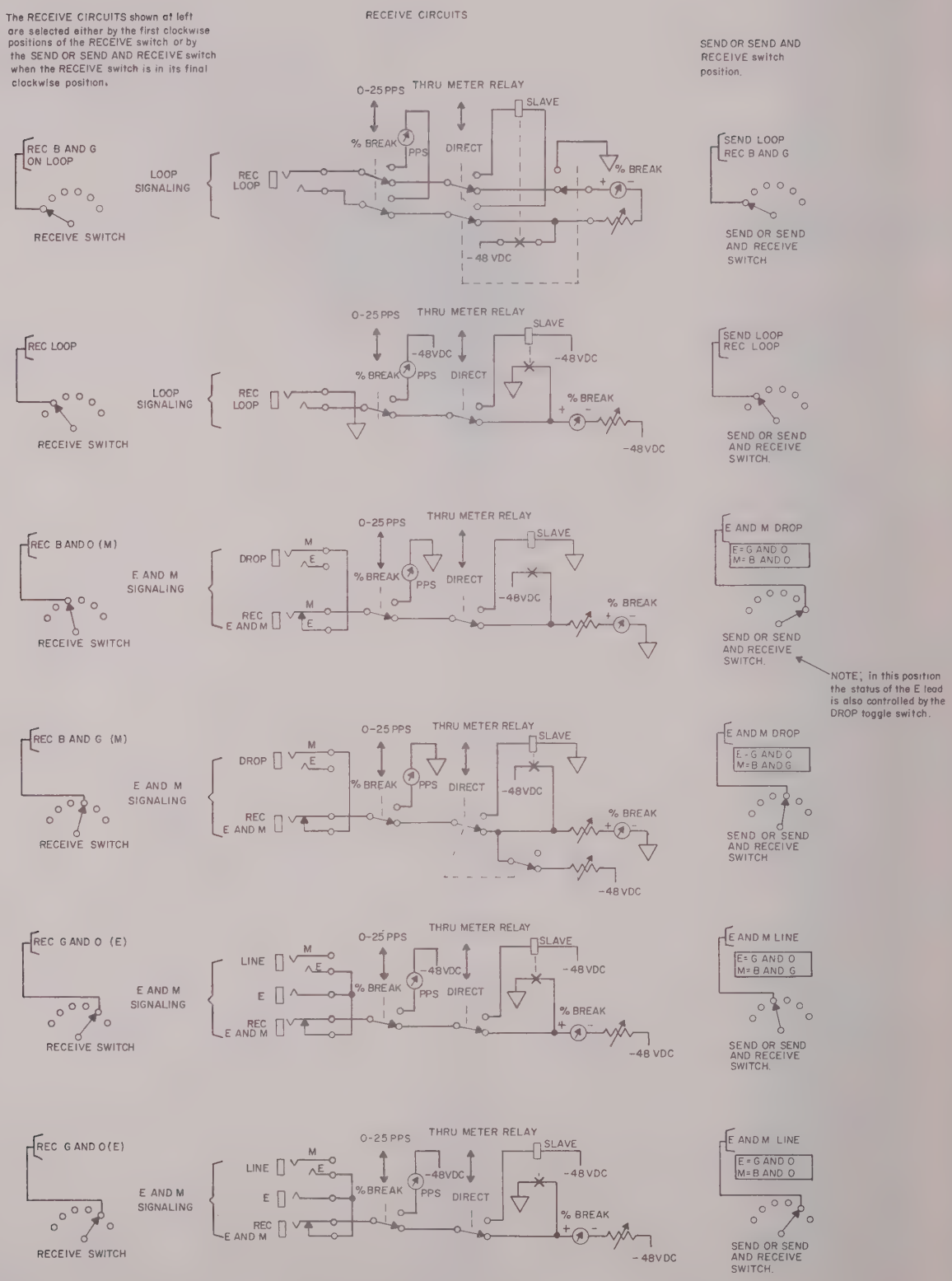


Figure 3-3 RECEIVE CIRCUITS

ACTION	RESULT
i. Turn the FUNCTION switch to SEND AND REC. CAUTION When the TTS 26B is used to pulse repeaters, carrier pulsing units, etc. care should be exercised to simultate the pulsing source in the system under test. In many cases the pulsing source will have a spark suppression circuit across the pulsing contacts. Under these conditions, if the spark suppression in the TTS 26B is not used erroneous results will be obtained. If required, turn the SPARK SUP turnbutton to ON, otherwise it should remain in the OFF position.	The set is now ready to send pulses at the required speed and % break. With the exception of the SEND or SEND AND REC switch, the positions of switches and keys in the set other than those covered are immaterial. If the pulse speed is changed the % break calibration should be checked.
j. To send on the M lead of a trunk with E and M supervision turn the SEND or SEND AND REC switch to E&M-LINE (E =G&O, M =B&G) for sending battery and ground, or to E&M-LINE (E =G&O, M =B&O) for sending battery and open.	
k. It is assumed that the trunk involved has been turned down to traffic. Patch the M lead of the trunk to the ring of the LINE jack or to the tip of the M jack .	
l. To send pulses from the internal oscillator operate the FUNCTION key to SEND OSC. To send with the dial of a telephone set, or with a dial connected to the EXT DIAL jack or terminals restore the FUNCTION key to SEND DIAL and turn the EXT DIAL CIRCUIT switch to DIAL RELAY-B&G. This also applies to a dry contact external source connected to the EXT DIAL jack or terminals. If the external source supplies wet contact pulses the EXT DIAL CIRCUIT switch . should be turned to DIAL RELAY-LOOP (See Note 1).	
m. To send on the E lead of a trunk with E and M supervision, turn the SEND or SEND AND REC switch to E&M-DROP (E =G&O, M =B&G) or to E&M-DROP (E =G&O, M =B&O). For sending ground and open the circuit for the E lead is the same in both cases. However, in the latter position of the switch (extreme clockwise) the toggle switch in the upper left-hand corner of the panel must be operated to the DROP-E =G&O position for sending ground and open. (See Note 1).	
n. It is assumed that the trunk involved has been turned down to traffic. Patch the E lead of the trunk to the tip of the DROP jack (do not use the E jack).	

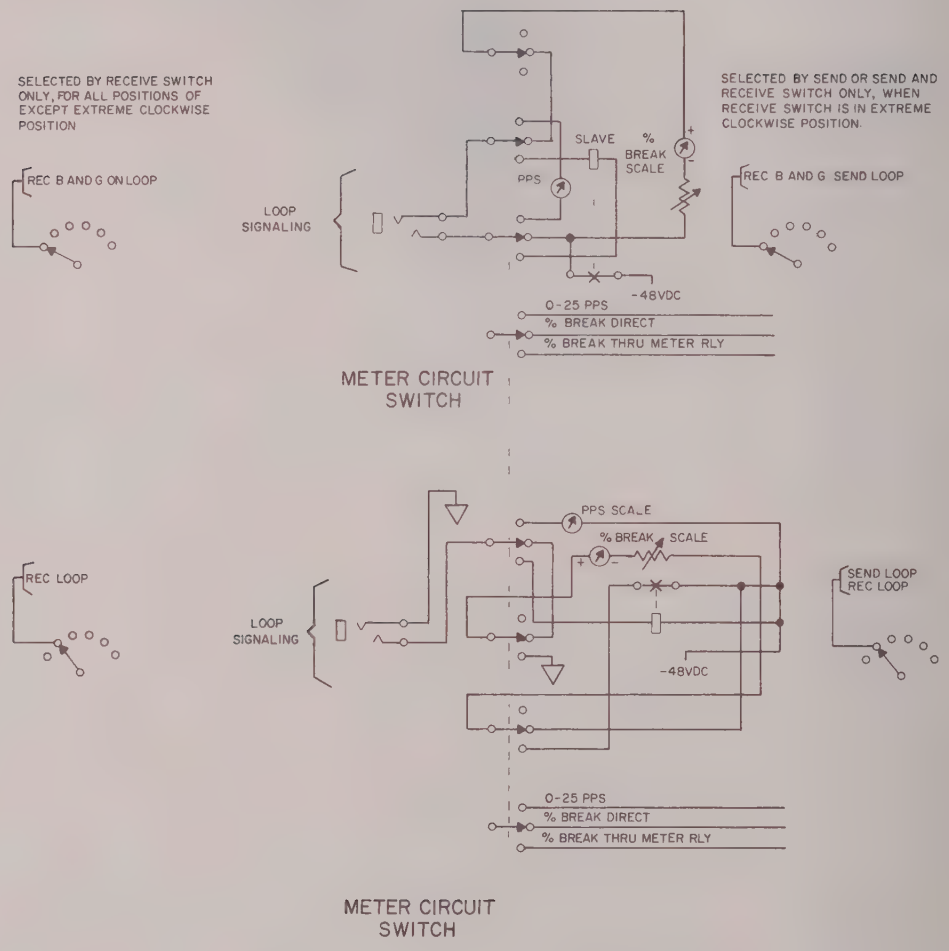


Figure 3-3a METER CIRCUIT

ACTION	RESULT
o. To send pulses from the internal oscillator operate the FUNCTION key to SEND OSC. To send with the dial of a telephone set, or with a dial connection to the EXT DIAL jack or terminals restore the FUNCTION key to SEND DIAL and turn the EXT DIAL CIRCUIT switch to DIAL RELAY- B&G. This also applies to a dry contact external source connected to the EXT DIAL jack or terminals. If the external source supplies wet contact pulses, the EXT DIAL CIRCUIT switch should be turned to DIAL RELAY-LOOP. (See Note 3).	

NOTE 2: If it is desired to send ground and battery the SEND or SEND AND REC switch must be in the extreme clockwise position and the DROP toggle switch must be operated to DROP - E =G&B.

NOTE 3: If the trunk test is patched through the LINE and DROP jacks of the TTS 26B and the set is sending on the M lead, the trunk may be made busy toward the drop by operating the DROP (M) key to OFF HOOK Similarly, sending on the E lead the trunk may be made busy toward the line by operating the LINE (E) key to OFF HOOK. This is shown in schematic form in fig. 3-2.

3.17 MEASURING % BREAK OF A RECEIVED SIGNAL. In all these measurements it is important to adjust the METER CAL control to take into account the voltage drop across any resistance between the source of the signals and the measuring set. This is accomplished while the METER CAL control is being adjusted, by having a short circuit or off hook present at the source of signals. It also is important that this adjustment should be made AFTER the receiving mode of the measuring set has been established by the RECEIVE switch (or the SEND or SEND AND REC switch if this switch controls the receiving as well as the sending modes). If another TTS 26B is being used as the source of signals, the off hook may be applied to the trunk by opening its FUNCTION switch to SEND-OFF HOOK.

3.18 MEASURING % BREAK ON LOOP CIRCUITS. The following provides the procedure for Measuring % Break on Loop Circuits (See fig. 3-3a):

ACTION	RESULT
a. With no power applied to the set, check the position of the meter pointer.	It should be on the 100 line of the % BREAK scale (meter electrical 0). If it is off adjust the screw on the front of the meter case to bring it to this line.
b. After adjustment, back off the adjustment screw slightly to remove mechanical contact between the adjustment screw and the meter mechanism.	This completes the mechanical adjustment of the meter electrical 0.
c. FIRST insert the 310-type plug of the power supply patch cord into the 48 VOLT jack of the set observing the proper tip and sleeve polarity, and then connect it to the 48-volt dc supply.	If connection is not made in this sequence a battery supply fuse may blow. If the wrong 48-volt jack is used diode protection within the set will protect the set from damage, but the set will be inoperative in succeeding steps.

ACTION	RESULT
d. Turn the SEND PPS switch to any position except PWR OFF.	This turns the set on. The LINE (E) and DROP (M) lamps should light. If they do light proceed to step f. If they do not light proceed to step e.
e. If the lamps did not light remove the dc power supply first, then change the 310-type plug to the other 48 VOLT jack, and then reconnect the 48-volt dc power supply.	The lamps should light. If they still do not the set probably is not receiving power.
f. For wet loop circuits turn the RECEIVE switch to B&G ON LOOP, or if this switch is used in the fully clockwise position to transfer control to the SEND or SEND AND REC switch, turn the (latter) switch to SEND LOOP-REC B&G. For dry loop circuits turn the RECEIVE switch to REC LOOP, or if this is used in the fully clockwise position to transfer control to the SEND or SEND AND REC switch, turn that (latter) switch to SEND LOOP-REC LOOP. If the set is being used for simultaneous sending with this switch in the SEND LOOP-REC LOOP position, the turnbutton in the lower left corner of the panel MUST be turned to SEND RT ON 1&2.	
g. Turn the METER CIRCUIT switch to % BREAK DIRECT.	If the circuit has high inductance or capacitance that may distort the pulse wave shape, the METER CIRCUIT switch should be turned to % BREAK THRU METER RELAY instead or erroneous readings may be obtained.
h. The FUNCTION, LINE (E) AND DROP (M) keys should be normal unless required for simultaneous sending. The EXT DIAL CIRCUIT switch is not in the measuring circuit. The SPARK SUP. turnbutton is not involved.	
i. It is assumed that the loop circuit involved has been turned down to traffic. At the measuring TTS 26B patch the circuit to the LOOP SIGNALING-REC LOOP jack, with a cord having a 310 type plug on the end toward the set. If a wet loop is involved the battery (-) should be on the tip and ground (+) on the ring.	
j. Request an off hook or short circuit at the point where the signals are to be applied.	
k. Turn the FUNCTION switch to CAL METER.	Adjust the METER CAL control to obtain 0 on the % BREAK scale of the meter.
1. Turn the FUNCTION switch to SEND AND REC, and request the distant end to send the signal to be measured instead of the off hook or short circuit.	Read the % BREAK on the % BREAK scale of the meter of the set at the measuring end.

3.19 MEASURING % BREAK ON THE M LEAD. The following provides for Measuring % Break on an M lead (See fig. 3-3b):

ACTION	RESULT
a. With no power applied to the set, check the position of the meter pointer.	It should be on the 100 line of the % BREAK scale (meter electrical 0.) If it is off adjust the screw on the front of the meter case to bring it to this line.
b. After adjustment back off the adjustment screw slightly to remove mechanical contact between the adjustment screw and the meter mechanism.	This completes the mechanical adjustment of the meter electrical 0.
c. FIRST insert the 310-type plug of the power supply patch cord into the 48 VOLT jack of the set observing the proper tip and sleeve polarity, and then connect it to the 48-volt dc supply.	If connection is not made in this sequence a battery supply fuse may blow. If the wrong 48-volt jack is used diode protection within the set will protect the set from damage, but the set will be inoperative in succeeding steps.
d. Turn the SEND PPS switch to any position except PWR OFF.	This turns the set on. The LINE (E) and DROP (M) lamps should light. If they do light proceed to step f. If they do not light proceed to step e.
e. If the lamps did not light remove the dc power supply first, then change the 310-type plug to the other 48 VOLT jack, and then reconnect the 48-volt dc power supply.	The light should light. If they still do not the set probably is not receiving power.
f. To measure % break of battery and open pulses on the M lead turn the RECEIVE switch to REC B&O, (M) or if this switch is used in the fully clockwise position to transfer control to the SEND or SEND AND REC switch turn that (latter) switch to E&M - DROP, E =G&O, M =B&O. To measure % break of battery and ground pulses on the M lead turn the RECEIVE switch to REC B&G (M) or if this switch is used fully clockwise to transfer control to the SEND or SEND AND REC switch turn the (latter) switch to E&M-DROP E =G&O, M =B&G.	
g. Turn the METER CIRCUIT switch to % BREAK DIRECT.	If the circuit has high inductance or capacitance which may distort the pulse wave shape the METER CIRCUIT switch should be turned to % BREAK THRU METER RELAY or erroneous readings may be obtained.
h. The FUNCTION, LINE (E) and DROP (M) keys should be normal unless required for simultaneous sending. The LINE (E) key may be operated to OFF HOOK to make the trunk busy toward the line. The EXT DIAL CIRCUIT switch is not in the measuring circuit. The SPARK SUP turnbutton is not involved.	

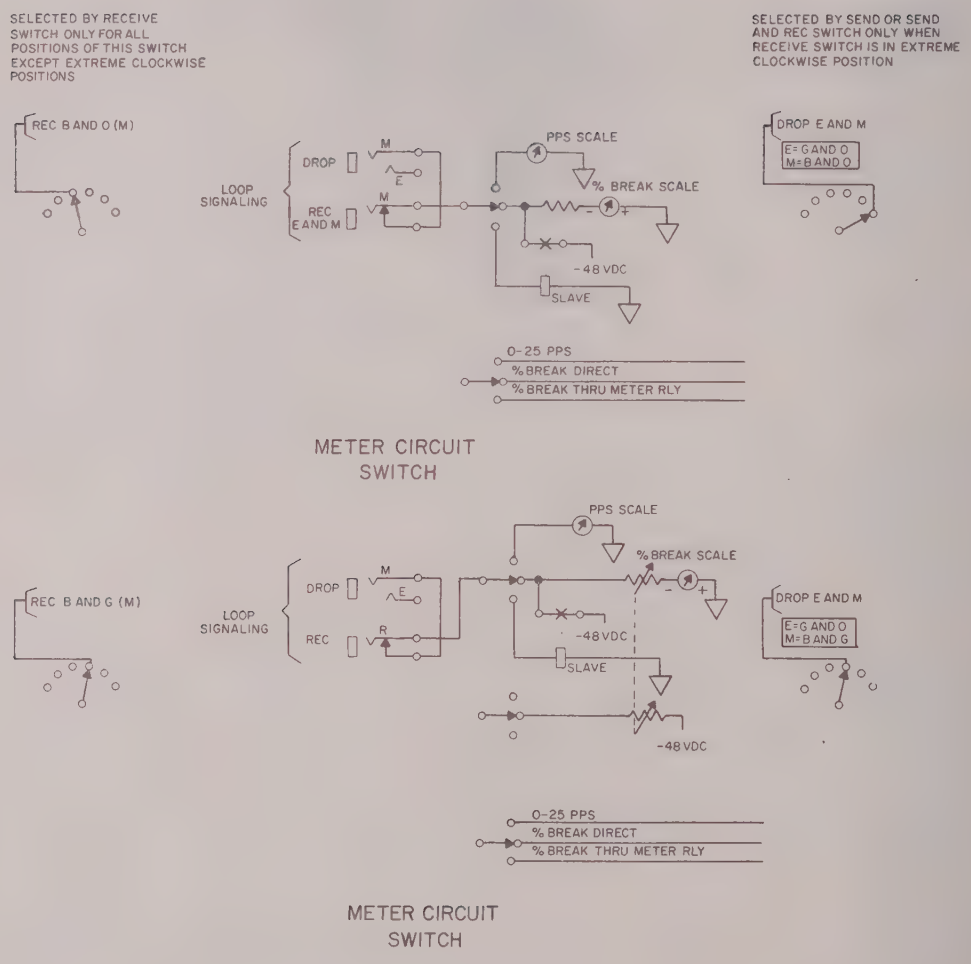


Figure 3-3b METER CIRCUIT

ACTION	RESULT
i. It is assumed that the trunk with E and M supervision has been turned down to traffic. At the measuring TTS 26B patch the M lead of the trunk to the ring or the DROP jack or to the ring of the E AND M SIGNALING-REC E&M jack, with a cord having a 310-type plug on the end toward the set.	
j. Request an off hook or a short circuit on the trunk to the point where the signals are to be applied.	
k. Turn the FUNCTION switch to CAL METER	Adjust the METER CAL control to obtain 0 on the % BREAK scale of the meter.
1. Turn the FUNCTION switch to SEND AND REC, and request the distant end to send the signal to be measured instead of the off hook or short circuit.	Read the % break on the % BREAK scale of the meter of the set at the measuring end.

3.20 MEASURING PERCENT BREAK ON THE E LEAD: The following provides the procedure for Measuring % Break on an E lead (See fig. 3-3c):

ACTION	RESULT
a. With no power applied to the set, check the position of the meter pointer.	It should be on the 100 line of the % BREAK scale (meter electrical 0). If it is off adjust the screw on the front of the meter case to bring it to this line.
b. After adjustment back off the adjustment screw slightly to remove mechanical contact between the adjustment screw and the meter mechanism.	This completes the mechanical adjustment of the meter electrical 0.
c. FIRST insert the 310-type plug of the power supply patch cord into the 48 VOLT jack of the set observing proper tip and sleeve polarity, and then connect it to the 48-volt dc supply.	If connection is not made in this sequence a battery supply fuse may blow. If the wrong 48-volt jack is used diode protection within the set will protect the set from damage, but the set will be inoperative in succeeding steps.
d. Turn the SEND PPS switch to any position except PWR OFF.	This turns the set on. The LINE (E) and DROP (M) lamps should light. If they do light proceed to step f. If they do not light proceed with step e.
e. If the lamps did not light remove the dc power supply first, then change the 310-type plug to the other 48 VOLT jack, and then reconnect the 48-volt dc power supply.	The lamps should light. If they still do not the set probably is not receiving power.
f. To measure % BREAK of ground and open pulses on the E lead turn the RECEIVE switch to REC G&O (E), or if this switch is used in fully clockwise position to transfer control to the SEND or SEND AND REC switch turn the (latter) switch either to E&M LINE, E =G&O, M =B&G or to E&M-LINE E =B&O, M =B&O.	

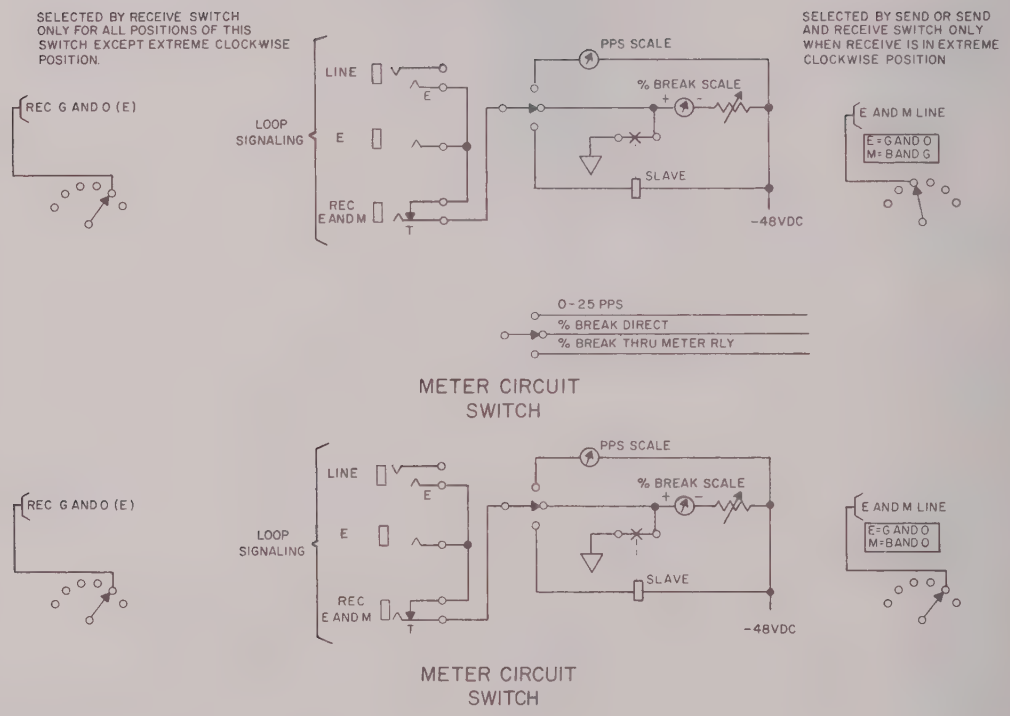


Figure 3-3c METER CIRCUIT

ACTION	RESULT
g. Turn the METER CIRCUIT switch to % BREAK DIRECT.	If the circuit has high inductance or capacitance which may distort the pulse wave shape the METER CIRCUIT switch should be turned to % BREAK THRU RELAY instead or erroneous readings may be obtained.
h. The FUNCTION, LINE (E) and DROP (M) keys should be normal unless required for simultaneous sending. The DROP (M) key may be operated to OFF HOOK to make the trunk busy toward the drop. The EXT DIAL CIRCUIT switch is not in the measuring circuit. The SPARK SUP turnbutton is not involved.	
i. It is assumed that the trunk with E and M supervision has been turned down to traffic. At the measuring TTS 26B patch the E lead of the trunk to the E jack (tip), the tip of the LINE jack, or the tip of the REC E&M jack, with a cord having a 310-type plug on the end toward the set.	
j. Request an off hook or a short circuit on the trunk at the point where the signals are to be applied.	
k. Turn the FUNCTION switch to CAL METER.	Adjust the METER CAL control to obtain 0 on the % BREAK scale of the meter.
l. Turn the FUNCTION switch to SEND AND REC, and request the distant end to send the signal to be measured instead of the off hook or short circuit.	Read the % break on the % BREAK scale of the meter of the set at the measuring end.

3.21 MEASURING THE PULSE SPEED OF A SIGNAL. The following provides the procedure for Measuring the Pulse Speed of a Signal:

ACTION	RESULT
a. With no power applied to the set, check the position of the meter pointer.	It should be on the 0 line of the PPS scale (meter electrical 0). If it is off adjust the screw on the front of the meter case to bring it to this line.
b. After adjustment, back off the adjustment screw slightly to remove mechanical contact between the adjustment screw and the meter mechanism.	This completes the mechanical adjustment of the meter electrical 0.
c. FIRST insert the 310-type plug of the power supply patch cord into the 48 VOLT jack of the set observing proper tip and sleeve polarity, and then connect it to the 48-volt dc supply.	If connection is not made in this sequence a battery supply fuse may blow. If the wrong 48-volt jack is used diode protection within the set will protect the set from damage, but the set will be inoperative in succeeding steps.

ACTION	RESULT
d. If the speed of the pulses being generated by the internal oscillator is to be measured, turn the SEND PPS switch to the speed to be measured. Otherwise turn this switch to any position except PWR OFF.	This turns the set on. The LINE (E) and DROP (M) lamps should light. If they do light proceed to step f. If they do not light proceed to step e.
e. If the lamps did not light remove the dc power supply first, then change the 310-type plug to the other 48 VOLT jack, and then reconnect the 48-volt dc power supply.	The lamps should light. If they still do not the set probably is not receiving power.
f. For a measurement over a dry loop circuit such as from the internal oscillator or from a dial connected to the EXT DIAL jack or terminals, or from a distant office over such a circuit, turn the RECEIVE switch to REC LOOP. If the pulses are to be received over a wet loop turn the RECEIVE switch to REC B&G ON LOOP.	
g. Turn the METER CIRCUIT switch to 0-25 PPS.	
h. If the measurement is to be made over a loop circuit from a distant office patch the circuit (turned down to traffic) to the LOOP SIGNALING REC LOOP jack. If a wet loop is involved battery (-) should be on the tip and ground (+) on the ring. If the internal oscillator or a local dial is to be measured patch the LOOP SIGNALING SEND 1 or 2 jack to the LOOP SIGNALING REC LOOP jack, tip and ring, with a cord having a 310-type plug on each end. If a dial is to be measured locally connect it to the EXT DIAL jack or terminals.	
i. Turn the FUNCTION switch to CAL METER.	Adjust the METER CAL control to obtain 25 on the PPS scale.
j. If the internal oscillator is to be measured operate the FUNCTION key to SEND OSC. If a measurement of a local dial speed or a measurement of pulses received from a distant office is to be made restore the FUNCTION key to SEND DIAL, and turn the EXT DIAL switch to DIAL RELAY-B&G.	If measuring a local dial, dial a series of zeros during measurement. If receiving from a distant office request it to send the pulses for the speed measurement.
k. The LINE (E) and DROP (M) keys should be normal. The EXT DIAL CIRCUIT switch is not in the measuring circuit. The SPARK SUP turn-button is not involved.	
l. Turn the FUNCTION switch to SEND AND REC	Read the pulse speed in pulses per second on the PPS scale of the meter.

3.22 SIMULTANEOUS RECEIVING AND SENDING. The set may be used to send signals with a predetermined % break into one circuit while receiving incoming signals from another circuit. Thus (1) the % break of the incoming signal may be measured while sending an outgoing signal. On the other hand (2) the incoming signal may be used to control the speed of outgoing pulses which are adjusted to a predetermined % break, thus making a pulse repeater out of the set, or (3) the incoming pulses from one type of circuit may be converted to pulses with the same or changed % break outgoing into another type of circuit. (4) The set may be used to receive dry loop pulses and simultaneously send out wet loop pulses, or vice versa.

3.23 In any case the SEND PPS switch and the ADJ % BREAK control are set for the desired values for the outgoing signal and then are not changed when adjusting the set for receiving the incoming signal, whether it is a measurement, a repeater operation, or a conversion. For repeating the pulses both the speed and the % break would be adjusted for the known values of the incoming signal. For a conversion the outgoing pulse speed should be the same as the incoming pulse speed, but the % break may be the same or different from the incoming signal. For a measurement of the incoming signal while the set is simultaneously sending outgoing signals, just as in the case of any receiving measurement, the METER CAL control must be adjusted to take into account any voltage drop across any resistance between the set and the point of application of the signal to the circuit to be measured. Since this does not involve changing the pulse speed and % break controls it does not alter the settings of the previously adjusted pulse speed and % break of the outgoing signal. If the incoming pulse is merely repeated or converted (but not measured) adjustment of the METER CAL control is not necessary as long as it is set near its mid range.

3.24 For the first case listed in para. 3.22 the procedures should be evident, keeping in mind that the pulse speed and adjustment of the % break for the sending signal must be adjusted first and that pulse speed and % break controls must not be changed when setting up the procedure for the receiving measurement. This also applies to the fourth case.

3.25 USING THE TTS 26B AS A PULSE REPEATER OR CONVERTER The following procedures provide for the Use of Set as a Pulse Repeater or Converter (paragraph 3.22).

ACTION	RESULT
a. With no power applied to the set, check the position of the meter pointer.	It should be on the 100 line of the % BREAK scale (meter electrical 0). If it is off adjust the screw on the front of the case to bring it to this line.
b. After adjustment, back off the adjustment screw slightly to remove contact between the adjustment screw and the meter mechanism.	This completes the mechaincal adjustment of the meter electrical 0.
c. FIRST insert the 310-type plug of the power supply patch cord into the 48 VOLT jack of the set observing the proper tip and sleeve polarity, and then connect it to the 48-volt dc supply.	If connection is not made in this sequence a battery supply fuse may blow. If the wrong 48-volt jack is used diode protection within the set will protect the set from damage, but the set will be inoperative in succeeding steps.
d. Turn the SEND PPS switch to the known pulse rate of the incoming signal. Do not change this setting in subsequent steps.	This turns the set on. The LINE (E) and DROP (M) lamps should light. If they do light proceed to step f. If they do not light proceed to step e.
e. If the lamps did not light remove the dc power supply first, then change the 310-type plug to the other 48 VOLT jack, and then reconnect the 48-volt dc power supply.	The lamps should light. If they still do not the set probably is not receiving power.

ACTION	RESULT
f. Turn the SEND or SEND AND REC switch to the sending mode desired for the outgoing signal and circuit.	
CAUTION When the switch is in the extreme clockwise position the DROP toggle switch must be operated to the desired E=G&O or E=G&B position.	
g. Operate the FUNCTION key to SEND OSC.	
h. Turn the FUNCTION switch to CAL METER.	Adjust the METER CAL control to obtain 0 on the % BREAK scale of the meter.
i. Turn the FUNCTION switch to CAL % BREAK	Adjust the ADJ % BREAK control to the % break desired for the outgoing signal of the meter. Do not change this setting in subsequent steps
j. Connect the circuit on which the repeated or converted pulses are to be sent to the appropriate LOOP SIGNALING, or E&M SIGNALING sending jack, as covered in the paragraphs on sending procedures.	
k. Turn the RECEIVE switch to the required receiving mode. If this corresponds to the established mode indicated by the already established setting of the SEND or SEND AND REC switch the RECEIVE switch may be turned to the extreme clockwise position instead.	For wet loops this setting should be REC B&G ON LOOP (or SEND LOOP, REC B&G), and for dry loops this should be REC LOOP (or SEND LOOP, REC LOOP).
l. Turn the METER CIRCUIT switch to % BREAK DIRECT	If the circuit has high inductance or capacitance which may distort the pulse wave shape the METER CIRCUIT switch should be turned to % BREAK THRU METER RELAY instead, or erroneous readings may be obtained.
m. Connect the circuit with the incoming signals to the EXT DIAL jack or terminals.	
n. Turn the EXT DIAL CIRCUIT switch to the applicable position in the following tabulation:	
(1) DIAL RELAY LOOP	Used when dry contact pulsing is received on a loop or is generated by a dial.
(2) DIAL RELAY LOOP	Used when wet contact pulsing is received on a loop.
(3) DIAL RELAY M	Used to receive battery and open or battery and ground pulses on an M lead.
(4) DIAL RELAY E	Used to receive ground and open pulses on an E lead.

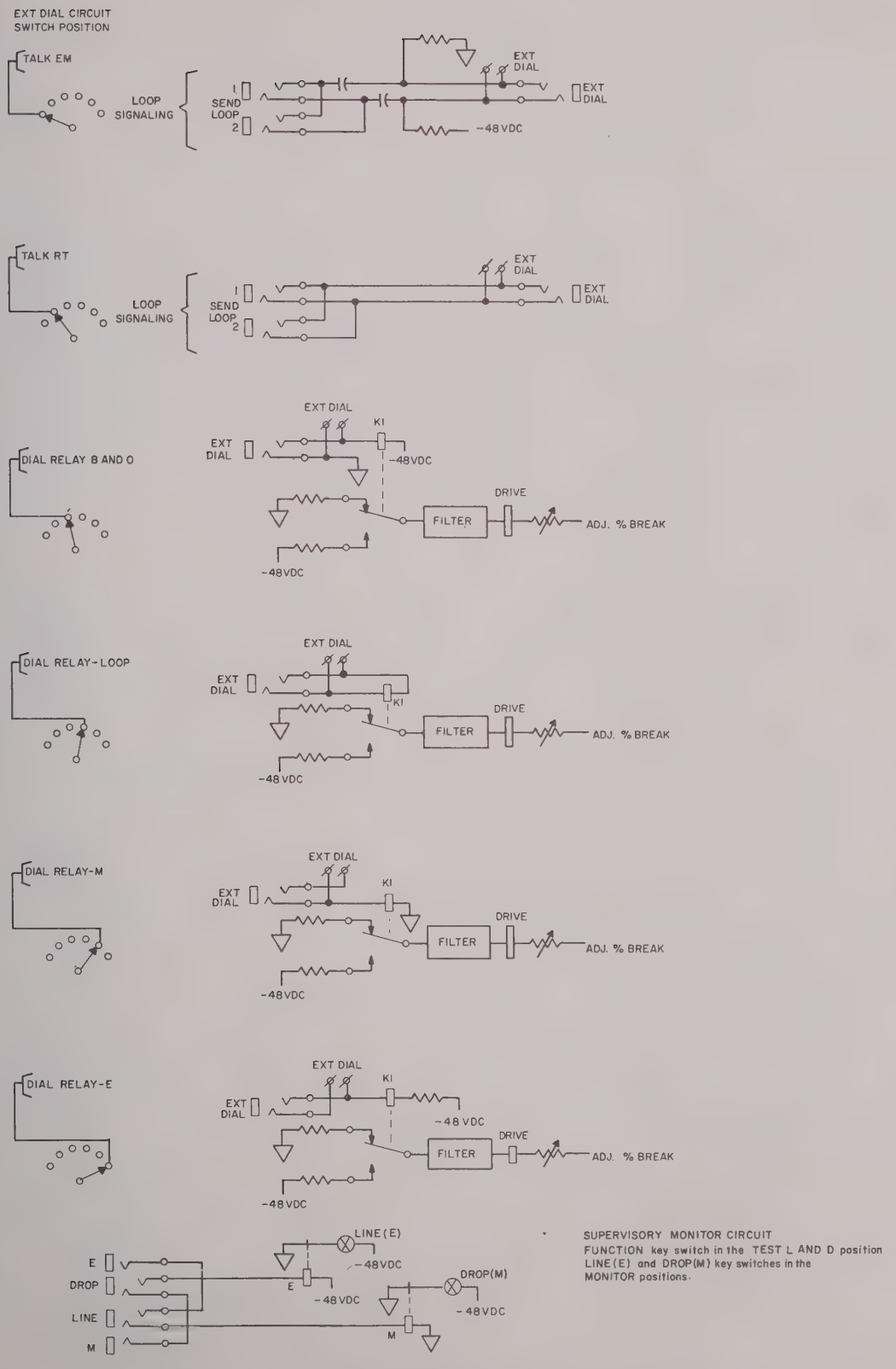


Figure 3-4 SUPERVISORY MONITOR CIRCUITS

ACTION	RESULT
o. Turn the FUNCTION switch to SEND AND REC.	
p. Restore the FUNCTION key to SEND DIAL.	The repeated or converted pulses with the predetermined % break should then be outgoing on the selected circuit.

3.26 SPECIAL FUNCTIONS

3.27 The following is the procedure for Pulsing and Open and Short on the Sleeves of the LOOP SIGNALING SEND 1 and 2, and the REC LOOP jacks:

ACTION	RESULT
a. With no power applied to the set, check the position of the meter pointer.	It should be on the 100 line of the % BREAK sacle (meter electrical 0) If it is off adjust the screw on the front of the meter case to bring it to this line.
b. After adjustment, back off the adjustment screw slightly to remove contact between the adjustment screw and the meter mechanism.	
c. FIRST insert the 310-type plug of the power supply patch cord into the 48 VOLT jack of the set observing proper tip and sleeve polarity, and then connect it to the 48-volt dc supply.	If connection is not made in this sequence a battery supply fuse may blow. If the wrong 48-volt jack is used diode protection within the set will protect the set from damage, but the set will be inoperative in succeeding steps.
d. Turn the SEND PPS switch to the desired pulse rate if the internal oscillator is to be used as the source of signals. If a dial or other external source is to be used turn the switch to any position except PWR OFF.	This turns the set on. The LINE (E) and DROP (M) lamps should light. If they do light proceed to step f. If they do not light proceed to step e.
e. If the lamps did not light remove the dc power supply first, then change the 310-type plug to the other 48 VOLT jack, and then reconnect the 48-volt dc power supply.	The lamps should light, If they still do not the set is probably not receiving power.
f. If the internal oscillator is to be used as the source of pulses, operate the FUNCTION key to SEND OSC. If a dial or other external source of pulses is to be used, restore the FUNCTION key to DIAL RELAY-B&G, and connect it to the EXT DIAL jack or terminals.	If the internal oscillator is used this starts it pulsing at the rate determined in step d. If a dial or other external source is used a series of zeros must be dialed or the external source must be operated during the calibration procedure
g. Turn the FUNCTION switch to CAL METER.	Adjust the METER CAL control to obtain 0 on the % BREAK scale of the meter.
h. Turn the FUNCTION switch to ADJ % BREAK	Adjust the ADJ % BREAK control to the desired % break as indicated on the meter. If a dial is used to generate the signal, dial a series of zeros when adjusting to the desired % break.
i. Turn the SEND or SEND AND REC switch to SEND LOOP-REC LOOP.	

j. Turn the turnbutton in the lower left corner of the panel to SEND SLEEVES.

k. Turn the FUNCTION switch to SEND AND REC.

(1) Armature of pulsing relay on the sleeve of SEND 2 jack.

(2) Sleeves of SEND 2 and REC LOOP jacks.

(3) Sleeves of SEND 2 and SEND 1 jacks.

3.28 The following is the procedure for using the Send Relay Contacts Directly. When a 310-type plug of a 3-conductor cord is inserted into the jack marked SEND RELAY, the tip, ring, and sleeve conductors of this cord give access to the contacts of the SEND relay and thereby permit pulsing external circuits such as oscillators, etc. at a speed and % break determined by the adjustment of the TTS 26B. All other circuits in the set are disconnected from the SEND relay contacts when the plug is in the SEND RELAY jack except for the spark supression. circuit. The position of the SPARK SUP turnbutton switch determines whether or not the spark suppression circuit is across the relay contacts. The SEND RELAY jack is connected to the SEND relay contacts as follows:

a. Tip: armature.

b. Ring: normally closed contact.

c. Sleeve: normally open contact.

3.29 Application of supervisory Signals to Circuits with E and M Signaling.

a. Patch the circuits to the E&M SIGNALING-LINE and DROP jacks.

b. Operate the LINE (E) key to OFF HOOK or ON HOOK to apply off hook or on hook, respectively, toward the line.

c. Operate the DROP (M) key to OFF HOOK or ON HOOK to apply off hook or on hook, respectively, toward the drop.

d. Receiving measurements may be made simultaneously.

3.30 Sending Off Hook or On Hook on a Circuit Connected to the LOOP SIGNALING-SEND 1 or 2 or SEND B&G jack, or to the E&M SIGNALING-LINE or DROP jack.

a. Patch the circuit to the appropriate LOOP SIGNALING-SEND jack or the appropriate E&M SIGNALING-E, M, LINE or DROP jack.

b. Turn the SEND or SEND AND REC switch to the appropriate position for the circuit to which the set is connected.

c. Turn the FUNCTION switch to SEND-OFF HOOK, or SEND-ON HOOK as desired.

SECTION 4

CIRCUIT DESCRIPTION

4.1 GENERAL.

4.2 A block diagram of the set is shown in fig. 4-1 and the schematic diagram of the instrument is shown in fig. 4-2. The circuits can be divided into two sections - the receive or measuring section, and the pulse send section. A detailed description of each section is presented below.

4.3 RECEIVING AND MEASURING SECTION.

4.4 The measuring section provides means for the speed or % break of pulses received from loop or E&M circuits. The RECEIVE switch is used to set up the measuring circuit for different modes of operation on loop or E&M circuits. The METER CIRCUIT switch connects the circuit under test to the meter for the measurement of pulse speed or % break. When % break is measured, the circuit under test may be connected directly to the meter or through a meter slave relay. The meter slave relay should be used for circuits with high capacitance or inductance which might distort the pulse sufficiently to give an erroneous reading when the meter is used directly.

4.5 The measuring circuit includes a 4 $\frac{1}{2}$" meter with a 1mA movement. A % BREAK scale calibrated from 0 to 100% in 1% divisions is used to facilitate reading % break. The R-C time constants of the meter circuit have been designed to permit proper reading of the % break when the digit 0 is dialed on an external dial. This damping is also sufficient to keep the angular vibration of the meter pointer to within approximately $\pm$1 division on the meter scale when a pulse rate of 10 pps is measured.

4.6 A PPS scale calibrated from 0 to 25 in 1 pps divisions is used to read pulse speed.

4.7 A calibration control in series with the meter permits setting an accurate full scale reading (i.e., 0% break) for battery voltages from approximately 40 to 55 volts.

4.8 When the meter circuit is required to measure the % break of battery and ground pulses, a compensating network, consisting of resistor R30 and R29B portion of the meter calibrating potentiometer, is switched into the meter circuit to provide an accurate reading under these conditions. It is to be noted that when receiving battery and ground pulses through the slave relay, R29B, is ganged to the meter calibration control so that it is automatically set to the proper value when the meter is calibrated for full scale, i.e., 0% break. It will be noted that the meter reads approximately 50% break when the set is not connected to a circuit and the RECEIVE switch is in the REC-B&G (M) position, and the FUNCTION switch is in the SEND AND REC position. The same measuring arrangement is provided when the sending and receiving functions are combined in the SEND switch and that switch is in the DROP (M =B&G, E =G&O) position.

4.9 The REC E&M jack makes it possible to receive on either the E or M lead from one circuit without interfering with sending operations on another circuit. When a plug is inserted in the REC E&M jack, the receive circuits are simultaneously disconnected from the E, M, LINE, and DROP jacks; these jacks can still be connected to an appropriate sending circuit by the SEND switch.

4.10 When the set is used for measuring incoming signals, the measuring circuits are connected to the appropriate jacks for receiving loop or E&M signals by the RECEIVE switch, which selects the desired mode of operation independent of the sending functions. The connections which can be established for each position of the RECEIVE switch are as follows in clockwise sequence:

a. REC B&G ON LOOP: The receive meter circuit is directly connected to the REC LOOP jack.

b. REC LOOP: The battery is furnished through the meter to the tip and ground is extended to the ring of the REC LOOP jack requiring only an open and closure of a dry loop for a measurement.

c. REC B&O (M): The meter circuit is connected to the ring of the REC E&M jack and the ring (M) of the DROP jack.

d. REC B&G (M): The meter circuit is connected to the ring of the REC E&M jack and the ring (M) of the DROP jack.

e. REC G&O (E): The meter circuit is connected to the tip of the REC E&M jack, to the E jack, and to the tip (E) of the LINE jack.

4.11 It is possible to combine the receiving and sending operations in fixed combinations by setting the RECEIVE switch to the extreme clockwise position. This transfers control of the

receiving mode of operation to the SEND switch. The SEND switch will then establish the receive connections as follows in clockwise sequence:

a. SEND LOOP, REC B&G: The receive meter circuit is directly connected to the REC LOOP jack.

b. SEND LOOP, REC LOOP: The battery is furnished through the meter to the tip, and ground is extended to the ring of the REC LOOP jack, requiring only an open and closure of a dry loop for a measurement.

c. LINE (M =B&G, E =G&O): The meter circuit is connected to the E jack and the tip (E) of the LINE jack.

d. DROP (M =B&O, E =G&O): The meter circuit is connected to the ring (M) of the DROP jack.

e. LINE (M =B&O, E =G&O): The meter circuit is connected to the E jack and tip (E) of the LINE jack.

f. DROP (M =B&O, E = G&O): The meter circuit is connected to the ring (M) of the DROP jack.

4.12 No connections are established between the measuring circuit and the REC E&M jack when the sending and receiving functions are combined in the SEND switch.

4.13 A description of the sending functions is covered in the section devoted to the sending part of the set. A diagram showing the circuit connections which are established for the combined sending and receiving operations is shown in fig. 3-3.

4.14 The receiving circuits are connected to the measuring circuit through the METER CIRCUIT switch as follows:

a. In the PPS position a relay is inserted in the external circuit; its contacts operate a frequency measuring circuit. In this condition the meter reads pulses per second (PPS).

b. In the center position, marked % BREAK DIRECT, the meter is operated as a % break meter and connected directly to the circuit under test.

c. In the % BREAK THRU RELAY position the winding of a slave relay is connected to the receiving circuits and the meter reads the % break on the contacts of this slave relay.

4.15 SENDING SECTION.

4.16 The sending section of the set provides the means for generating signals which may be sent on loop or E&M circuits. When the FUNCTION switch is in the SEND AND REC position, the TEST-SEND key switch selects the following sources of signal:

a. In its normal position a continuous pulse train controlled by an internal oscillator. The frequency of this oscillator can be controlled by the PULSES PER SEC switch.

b. In its operated down position dial pulses or other signals generated in circuits connected to the EXT DIAL jack.

In either case the % break of the send signals can be controlled by the ADJ % BREAK control, and can be measured on the % BREAK scale of the meter incorporated in the set. To check the % break of the transmitted signal, the FUNCTION switch is temporarily moved to the ADJ % BREAK position.

4.17 When the internal oscillator is used, a sine wave signal is supplied to one winding of the DRIVE relay. When an external dial circuit is used, signals having a wave shape approximating the sine wave are supplied to this same winding. The other winding of this relay is connected to a DC circuit in which positive or negative bias can be applied under the control of the ADJ % BREAK potentiometer. The DC bias shifts the operating point of the DRIVE relay and causes it to transmit pulses which are lengthened or shortened as compared to those transmitted in the absence of any bias.

4.18 In the biasing circuit described above, the effective drive power of the relay becomes unsymmetrical and appreciable amounts of armature transfer time can occur. Thus it is not desirable to derive the sending signals directly from the DRIVE relay. For this reason the contacts of the DRIVE relay are used to drive a second relay, the SEND relay. This second relay obtains full excitation whenever the DRIVE relay operates. As a result of the bi-stable characteristics of the SEND relay, assisted by

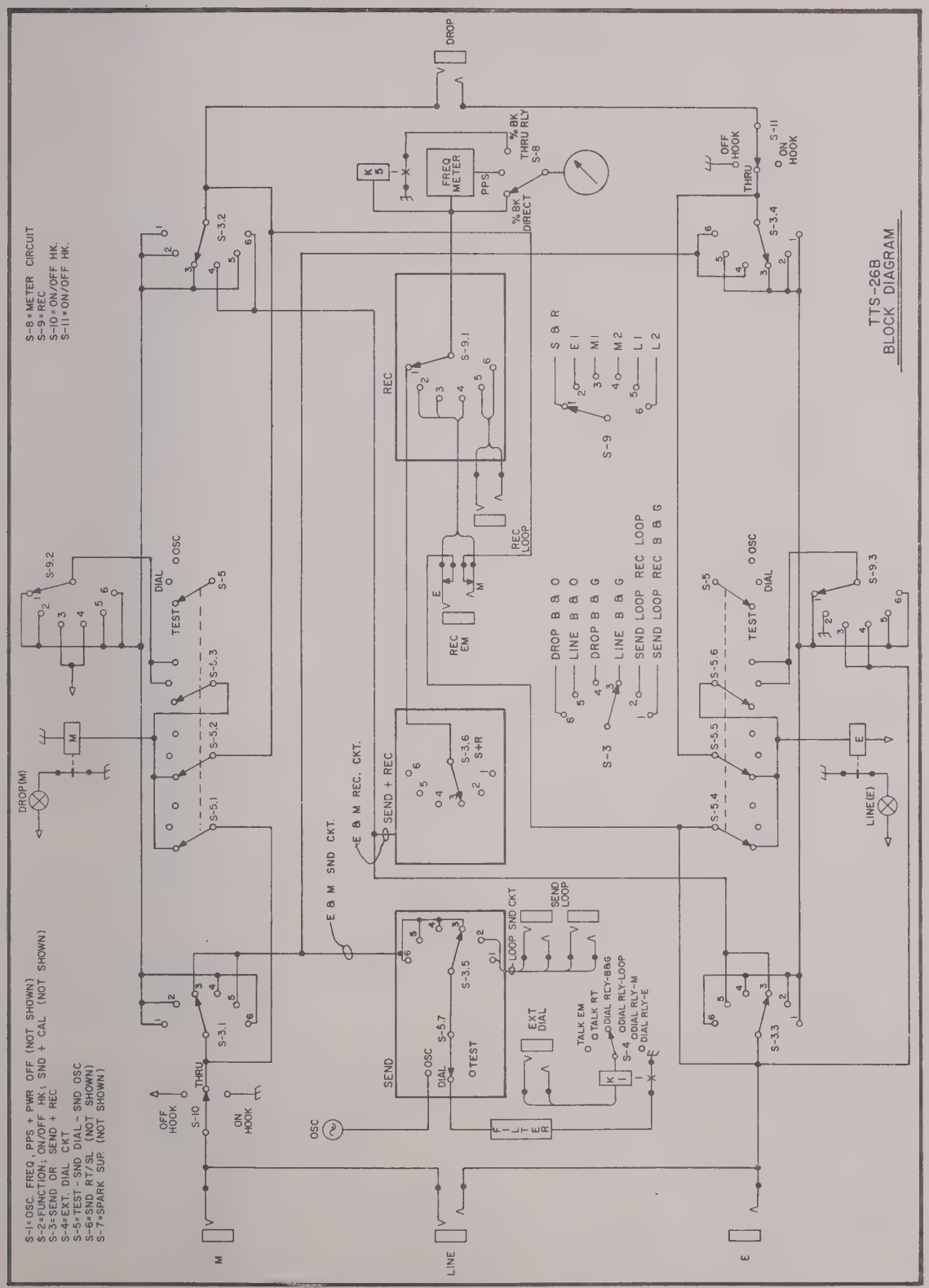


Figure 4-1 TTS 26B Block Diagram

the spark suppressors on the DRIVE relay contacts, the transfer time of the SEND relay is kept low under all conditions. In order to permit use of the TTS 26B for switching of voice frequency circuits, the spark suppressors can be omitted from the contacts of the SEND relay by operating the SPARK SUP turnbutton switch to OFF. If the TTS 26B is to be used on high power or highly inductive circuits, the internal spark suppressor circuit should be used. Access to the armature, make, and break contacts of the SEND relay is obtained on the tip, ring, and sleeve of the SEND RELAY jack.

CAUTION

If the TTS 26B SEND circuits will be switching currents of more than 100mA, voltages in excess of 50 volts, or inductive circuits, the internal SPARK SUP turnbutton should be operated to ON. This internal suppressor circuit, when connected, protects the SEND relay contacts with arc reduction networks of 0.1μF and 220Ω. These values are generally satisfactory for standard 48 relay switching circuits. Care must be used when spark suppression is added that the performance of the circuits under test is not affected by the spark suppression circuit.
PULSES PER SEC control to the position corresponding to the speed of the dial used.

4.19 The internal oscillator is a convential, transistorized, sine wave oscillator equipped with a buffer amplifier to provide the desired signal level to operate the DRIVE relay. When the external dial is used to control the SEND relay the operation of the dial causes the DIAL relay to operate. The armature of this relay applies battery or ground to a low pass filter. The output of the low pass filter has the sloping waveform which is necessary to obtain proper bias control in the DRIVE relay. To obtain maximum range of control, the filter condenser in the low pass filter should be switched to correspond to the dial speed. This is automatically done by turning the

4.20 When pulsing signals are generated by the internal oscillator, these signals are applied to the DRIVE relay directly by the SEND AND TEST key switch. When these signals are generated externally, it is also necessary to use the EXT DIAL CIRCUIT switch and set it in the position applicable to the external circuit conditions: fig. 3 shows the circuit connections which may be established under control of this switch. A further explanation of the use of the EXT DIAL CIRCUIT switch is presented in paragraph 4.21

4.21 Loop or E&M signals are connected to the appropriate SEND jacks by the SEND switch in the following manner in clockwise sequence:

a. SEND LOOP REC B&G: A pulsing open or short condition is applied to the tip and ring of the LOOP SIGNALING-SEND 1 and 2 jacks for circuits which provide battery and ground.

b. SEND LOOP REC LOOP: When the SEND turnbutton switch is in the RT ON 1&2 position, a pulsing open or short condition is applied to the tip and ring of the LOOP SIGNALING-SEND 1 and 2 jacks for circuits which provide battery and ground. When the SEND turnbutton switch is in the SLEEVES position, the amature of the SEND relay is connected to the sleeve of the LOOP SIGNALING SEND LOOP 2; the on hook contact of the SEND relay to the sleeve of the LOOP SIGNALING SEND LOOP 1; and the off hook contact to the sleeve of the REC LOOP jack. In this condition no connections are made to the T and R leads of SEND LOOP jacks 1 and 2.

c. LINE (M =B&G, E =G&O): Signaling with battery and ground applied to the M lead on the ring of the LINE jack and on the M jack. The battery is supplied through a resistance lamp.

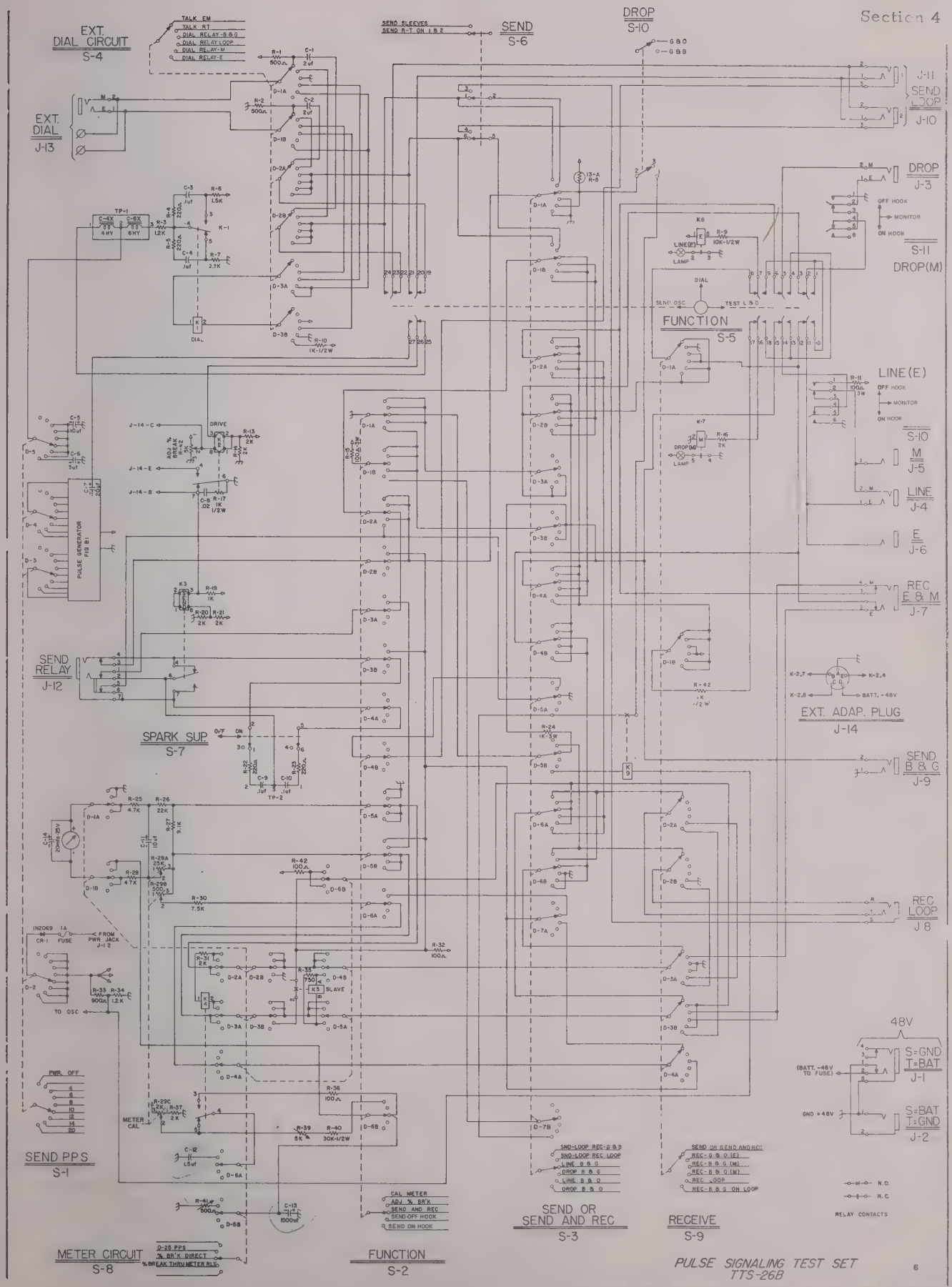
d. DROP (M =B&G, E =G&O): Signaling with ground and open applied to the E lead on the tip of the DROP jack.

e. LINE (M =B&O, E =G&O): Signaling with battery and open applied to the M lead on the ring of the LINE jack and on the M jack. The battery is supplied through a resistance lamp.

f. DROP (M =B&O, E =G&O): Signaling with ground and open applied to the E lead on the tip of the DROP jack.

The receive functions of the combined SEND and RECEIVE operations are covered in paragraph 4.9.

4.22 An additional loop signaling arrangement is provided in which battery and ground are applied to an external "dry" circuit under control of the SEND relay. This arrangement is available on the SEND B&G jack under LOOP SIGNALING


EXT. DIAL CIRCUIT S-4
EXT. DIAL J-13
SEND S-6
DROP S-10
J-11 SEND LOOP
J-10
DROP J-3
S-11 DROP(M)
FUNCTION S-5
LINE(E)
S-10 M J-5
LINE J-4
E J-6
REC E & M J-7
EXT. ADAP. PLUG J-14
SEND B & G J-9
REC LOOP J 8
48V
S=GND T=BAT J-1
S=BAT T=GND J-2
SEND RELAY J-12
SPARK SUP. S-7
SEND PPS S-1
METER CIRCUIT S-8
FUNCTION S-2
SEND OR SEND AND REC S-3
RECEIVE S-9
PULSE GENERATOR FIG 81
PULSE SIGNALING TEST SET TTS-26B

when the SEND switch is in the LINE (M=B&O, E=G&O) position. Battery and open appear on the ring and ground appears on the tip of the jack.

4.23 For special applications it may be desirable to have available means for pulsing the sleeves of the LOOP jacks. By turning the SEND turn-button switch to SLEEVES two different arrangements are obtained when the SEND switch is in the SEND LOOP REC LOOP position as follows:

a. A pulsing open and short condition is applied between the sleeves of the SEND 1 and 2 jacks.

b. A pulsing open and short condition is applied between the sleeve of the SEND 2 jack and the sleeve of the REC LOOP jack.

4.24 PULSE REPEATER AND PULSE CONVERTER FUNCTIONS.

4.25 External keying circuits may be connected through the EXT DIAL jack, or binding posts, which in turn cause the DIAL relay to follow the pulses as received Signals may derive from external loop or E&M circuits, or from an external dial.

4.26 The following functions are provided for each of the DIAL RELAY positions of the EXT DIAL CIRCUIT switch. A simplified schematic of these circuits is shown in fig. 3.4.

a. DIAL RELAY B&G: Ground is applied to the tip of the EXT DIAL jack through the relay, and battery is applied through to the ring. This permits dry contact pulsing to be received from the external circuit.

b. DIAL RELAY LOOP: The winding of the relay is connected directly to the EXT DIAL jack. This permits wet contact pulsing to be received from the external circuit.

c. DIAL RELAY M: One side of the relay winding is connected to ground, and the other side is connected to the ring of the EXT DIAL jack to receive signals from an M lead.

d. DIAL RELAY E: One side of the relay winding is connected to battery through a 1000Ω resistor, and the other side is connected to the tip of the EXT DIAL jack to receive signals from an E lead.

4.27 When the FUNCTION switch is in the SEND AND REC position and the SEND AND TEST key switch is in the DIAL position, the signal received on the EXT DIAL jack is retransmitted through whichever SEND jacks are selected by the SEND switch. By turning the FUNCTOIN switch temporarily to the ADJ % BREAK position, the % break of the signals transmitted by the send circuit may be controlled and measured. Thus, it is possible to use the set as a repeater with an adjustable % break, or to convert loop signals to E&M signals or vice versa, and also control the % break of the converted signal.

4.28 SEND RELAY Jack - When a cord is inserted in the jack marked SEND RELAY, the tip, ring, and sleeve of this cord give immediate access to the contacts of the SEND relay and thereby permit pulsing external circuits such as oscillators, etc., at an adjustable % break. All other circuits in the set are disconnected from the relay contacts when the SEND RELAY jack is used. The position of the SPARK SUP switch determines whether or not the spark suppression circuit is across the relay terminals.

4.29 Line and Drop Busy Test - When the TTS 26B is to be used on E&M circuits, it is desirable to determine first if the circuit is idle or not busy before applying any test signals to it. When the SEND-TEST key is in the TEST L&D position, and the TWD-L and TWD-D key switches are in the THRU & MEAS position, the E&M leads of the LINE and DROP jacks are connected through, and the LINE and DROP lamps are connected to the E and M leads respectively on the LINE, DROP jacks and also on the E and M jacks. When the lamps are lit, an on hook condition on the circuit under test is indicated. When the lamps are extinguished, an off hook condition is indicated. Normally, prior to connection of the TTS 26B to the circuit under test, both lamps are lighted as an indication of lamp circuit continuity.

4.30 Supervisory Signals - On hook and off hook signals may be applied independently toward the line and drop by means of the TWD-L and TWD-D key switches. When either of these keys is operated to either the ON HK or OFF HK position, the associated internal signaling circuits are removed from the line and drop and the desired supervisory signals are applied as follows:

a. TWD-L in OFF HK position, applies battery to the M jack and the M lead or ring of the LINE jack.

b. TWD-L in ON HK position, applies a ground to the M jack and the M lead or ring of the LINE jack.

c. TWD-D in OFF HK position, applies a ground to the E lead or tip of the DROP jack.

d. TWD-D in ON HK position applies an open to the E lead or tip of the DROP jack.

4.31 DIALING AND TALKING FUNCTIONS.

4.32 A lineman's telephone set or a subscriber's set may be connected to the EXT DIAL jack or binding posts to dial out or talk on a loop or E&M supervised circuit. The dialing functions have already been reviewed in paragraphs 4.17, 4.21, and 4.22.

4.33 When the EXT DIAL CIRCUIT switch is set at TALK EM or TALK RT, the EXT DIAL jack and binding posts are connected to the tip and ring of the SEND 1 and 2 jacks as follows:

a. TALK EM: The sending circuit is connected to the EXT DIAL jack through 2μF blocking capacitors, and battery is applied through 500Ω to the ring of the jack, and the tip is connected to ground through 500Ω. This provides battery for talking on a dry circuit.

b. TALK RT: The sending circuit is connected directly to the EXT DIAL jack to permit talking on a loop or wet circuit.

4.34 OSCILLATOR-BUFFER AMPLIFIER.

4.35 The oscillator-buffer amplifier circuitry contained within the Model TTS 26B Pulse Signaling Test Set is normally equipped to operate on any of the following frequencies: 4, 6, 8, 10, 12, 14, or 20 cps; an additional frequency can be installed on special order. The purpose of the oscillator-buffer circuitry is to provide an output sine wave to operate the DRIVE relay. This circuit is contained on a printed board which is mounted as a sub unit on the main component board.

4.36 The output sine wave of this unit is coupled to the DRIVE relay when the SEND and TEST key switch is in the OSC position: Through the adjustment of the ADJ % BREAK control, associated with the DRIVE relay, the point on this sine wave at which the DRIVE relay will operate can be varied thus the adjustable % break is achieved.

4.37 As transistorized circuits are used , no external power other than the 48-volt station battery is required; no warm-up period is required for this unit. , The operation of this circuit is as follows:

4.38 The circuit diagram to which the following description applies is shown in fig. 5.1. The location of the component part of this circuit is shown in fig. 5.2.

4.39 A bridged-T type of R-C oscillator, consisting of three transistor stages, is used. The first two transistors are directly coupled from the collector of Q1 to the base of Q2. The positive feedback path is completed from the emitter of Q2 back through a blocking capacitor, C2, and a tungsten lamp, R89, utilized for level stabilization, to the emitter of Q1. A part of the emitter resistance, R15, of Q1 has been made variable to allow setting the correct amount of positive feedback necessary for stable operation.

4.40 A negative feedback, which is greater than the positive feedback, is supplied to the base of Q1 through a null selective network and an emitter follower, Q3 At its tuned frequency, the selective bridged-T null network decreases the negative feedback sufficiently to permit oscillation to occur at the desired frequency, which is determined by the R-C values employed within the network. This frequency-determining network consists of two capacitors, C4 and C5, and two selected value resistors.

4.41 Amplifier stage Q4 and the cascade emitter follower stages, Q5 and Q6, provide the necessary voltage and current gain required to operate the DRIVE relay. The output level of the amplifier stage is determined by the setting of potentiometer R19. Capacitor C7 provides DC blocking between the output emitter follower Q6 and the driven coil of the DRIVE relay.

4.42 Pulse Speed Measuring Circuit.

4.43 When the METER CIRCUIT switch, S8, is in the 0-25 PPS position, a voltage directly proportional to the frequency of the signals received is generated by this pulse speed measuring circuit. This voltage is coupled to the meter, thus allowing direct reading of the speed of the signals as received by the set.

4.44 The operation of this circuit is as follows. When the METER CIRCUIT switch is in the 0-25 PPS position, the receive circuits are coupled to the coil of relay K4. Thus K4 will follow the pulses received When K4 is in the released condition, capacitor C12

will become charged to the voltage potential appearing on the arm of the METER CAL potentiometer R29C. When K4 operates, capactior C12 is transferred from its charging circuit to the meter and storage circuit. This storage circuit consists of capacitor C13. The energy previously stored in capacitor C12 has now been deposited in the meter storage circuit. The voltage potential to which the meter circuit can become charged is thus directly proportional to the pulsing speed of relay K4. Resistor R36 serves as a current limiting resistor for capacitor C12. Adjustable resistors R39 and R41 have been provided for calibration purposes. Resistor R40 is also part of the calibrating circuit.

SECTION 5

MAINTENANCE

5.1 GENERAL.

5.2 Apart from the normal periodic cleaning of the jack contacts, the TTS 26B does not require any routine maintenance.

5.3 If any abnormal operations occurs, it can easily be traced to one of five groups of circuits. These circuits are as follows:

1. Oscillator circuit.
2. Buffer-amplifier circuit.
3. Drive relay, send relay, and associated bias circuitry.
4. External dial and telephone set circuits.
5. Pulse speed measurnig circuit.

The general location of the major component parts of the TTS 26B is shown in figures 6-1 and 6-2.

NOTE

Unless otherwise specified, voltage or power readings apply between the point referred to and ground.

5.4 When the DRIVE relay fails to operate, the trouble is most likely to be traced to one of two causes:

1. Station battery polarity reversed.
2. Oscillator-buffer amplifier circuitry inoperative.

5.5 After the battery polarity has been checked, position the ADJ % BREAK control at its mid-position and conduct trouble shooting of the oscillator-buffer amplifier circuitry as follows.

5.6 Referring to fig. 5-1, connect an oscilloscope between point A and ground. Point A is shown in fig. 5-2 which is the drawing of the printed circuit board assembly. The sine wave voltage appearing between these two points should be approximately 2.5 volts peak to peak. If not, adjust potentiometer R15 to achieve this level. Turning R15 in a clockwise direction increases the positive feedback, and therefore increases the output level at point A. There should be no fluctuation of the signal level at this point once the level has been adjusted to approximately 2.5 volts peak to peak. A slight amount of clipping on the peaks of this waveform need not cause alarm, as this is normal.

5.7 If there is no voltage between point A and ground (with R15 in maximum clockwise position) check the filament of the tungsten lamp, R89, for continuity. Replace lamp if faulty. If the lamp is good, substitute transistors, starting with Q1 and ending with Q3. If trouble still prevails, check for proper DC voltages as indicated on the schematic diagrams, of the circuit. These voltages should be within ±10% as indicated. An open condition of filter capacitor C8 can also cause faulty operation and should be checked through substitution.

5.8 Should the preceding steps fail to produce an output of the oscillator at point A, check other component parts contained within the oscillator circuit, such as resistors, capacitors, and the pulse frequency switching network. It is important after the correction of the trouble to readjust potemtiometer R15 to produce a 2.5 peak to peak voltage indication at point A of the oscillator board.

5.9 With the oscillator operating properly, check the peak to peak boltage appearing at pin 3 of the DRIVE relay. This voltage should be in the order of 7 volts peak to peak. The exact voltage depends on the setting of the gain control R19. The normal setting for this control is approximately in its mid-position. If normal signal voltage is not realized at this point, check the buffer-amplifier portion of the circuit. This circuit consists of transistors Q4, Q5, Q6 and their associated circuitry.

5.10 If a normal driving voltage appears at pin 2 of the DRIVE relay and trouble still prevails, the trouble will be found in either the DRIVE relay, the SEND relay, or their bias networks. When the SEND BIAS control is in its mid-position, the DC voltage between pins 1 and 8 of the DRIVE relay shuold be very close to 0.

5.11 Should trouble be traced to either the DRIVE or SEND relay, it is recommended that these relays be removed and tested with proper test equipment such as the Sigma 4500 Series test set or equivalent. Should these relays require readjustment, it is recommended that it be done by qualified personnel familiar with the adjustment of this type of polar relay.

5.12 EXTERNAL DIAL and TELEPHONE SET CIRCUITS.

5.13 Should the external dial fail to produce pulses when switch S4 is in the appropriate position for the external dial circuit used, S5 in the DIAL position, and the ADJ % BREAK control in its mid-position, trouble shooting should proceed as follows;

5.14 The various components parts associated with this circuit are shown in figs. 6-2 and 6-3. Visual inspection of the DIAL relay will determine whether or not this relay is following the dial pulses as dialed. If this relay is not following the pulses, examine the external dial mechanism and the circuitry through the coil of this dial relay. If satisfactory operation of the dial relay has been observed, then trouble shooting should be centered around the low pass filter and its associated circuitry. While dialing, battery and ground should appear alternately on the armature of the DRIVE relay. If not, inspect resistors R3, R4, R5, R6, R7 and capacitors C3 and C4. These alternate battery and ground pulses can be traced to the filter, over contacts 25 and 26 of S5, to pin 3 of the DRIVE relay. The filter consists of inductors C4X, C6X and capacitors C5 and C6. The purpose of this filter is to convert the square wave as received for the proper operation of the DRIVE relay and its associated bias networks. Without the sloping waveform it would not be possible to control the % break transmitted by the set. The output waveform of this filter should approximate that of a sine wave. If capacitors C5 and C6 are suspected of being defective, these can most easily be checked through substitution. The total DC resistance reading between the armature of the DRIVE relay and the filter output as measured at terminal 25 of switch S5 should be in the order of 1700Ω when S5 is in the oscillator position. If this reading is not observed, locate and replace the defective component. Contacts 25 and 26 of S5 should also be inspected and cleaned if necessary. For dial pulse frequencies of 4, 6, 8, 10, 12 and 14 cps, capacitor C5 is switched into the filter circuitry, and capacitor C6 is switched into the filter circuitry when dial speeds of 20 cps are used. This switching is accomplished over the SEND PPS switch,

5.15 TALK CIRCUITS.

5.16 When the EXT DIAL CIRCUIT switch, S4, is in the TALK RT position and S5 is in the DIAL position, the external dial circuit is carried directly through to the T&R of SEND LOOP jacks 1 and 2. This is accomplished over contacts of S4 and S5. Should the TALK circuitry fail to operate in this position, the trouble will be traced to either the switching circuitry or the external talk mechanism.

5.17 When the EXT DIAL CIRCUIT switch is in the TALK E&M position, battery and ground are applied to the TALK circuit over resistors R1 and R2. The voltage generated by the TALK circuit is coupled to the T&R of SEND LOOP jacks 1 and 2 through DC blocking capacitors C1 and C2. Should the TALK circuit fail to function, inspect resistors R1, R2, capacitors C1, C2, the associated switch contacts of S4 and S5, and the external talk mechanism.

5.18 Pulse Speed Measuring Circuit.

5.19 Should the pulse speed measuring circuit fail to operate proceed as follows: Connect the receive circuitry of the TTS 26B to an external pulsing source of a known frequency, e.g 10pps. Calibrate the meter circuit as outlined in Section 5 of this manual. Return the METER CIRCUIT switch, S8, to its 0-25 PPS position Relay K4 should now be following the pulses as received from the external pulsing source When K4 is released, the voltage appearing on the arm of the calibration potentiometer, R29C, should also appear on the armature of K3. This voltage should be in the order of approximately 30 to 35 volts. If this voltage reading cannot be obtained, then inspect the relay contacts and R29C. Resistor R37, which is also part of the meter calibration circuit, should also be checked When relay K3 is operated, the voltage stored in capacitor C12 is then transferred to the meter and storage circuit through current limiting resistor, R36. If no meter indication is observed with the preceding circuitry operating properly, inspect capacitors C12 and C13. The trouble, if not located in the preceding operations, will then be most likely located in either the switching associated with the circuit or the meter circuit itself.

5.20 When the pulse speed circuit functions but does not indicate properly, the circuit should be recalibrated as follows: return the METER CIRCUIT switch, S8, to its % BREAK DIRECT position and perform calibration as outlined in Section 5 of this manual. After this calibration has been completed, position the METER CIRCUIT switch at its 0-25 PPS position. The meter should now read 0% break. If the meter did not read 0% break, adjust potentiometer R39 to achieve this reading. Move the FUNCTION

switch to its SEND AND REC position. Connect a 10 pps pulse source into the receive circuit of the TTS 26B. The meter should indicate a speed reading of 10 pps. If not, adjust potemtioneter R41 until this reading is obtained. As this is a linear circuit, no tracking adjustments are required. Should this circuit fail to track, then trouble shooting should be conducted as outlined under paragraph 5.19. After repair of the circuit, calibration should be rechecked as outlined above.

5.21 SLAVE RELAY CIRCUIT.

5.22 When the METER CIRCUIT switch, S8, is in its % BREAK THRU RELAY position, the received pulses are coupled directly to the coil of slave relay K4. The make contacts of this relay then in turn supply the pulses as received by the meter circuit. Should this circuit fail to operate, the trouble will be located either in the coil of the relay or the contacts. If the relay is found satisfactory, then the associated switching circuitry should be checked.

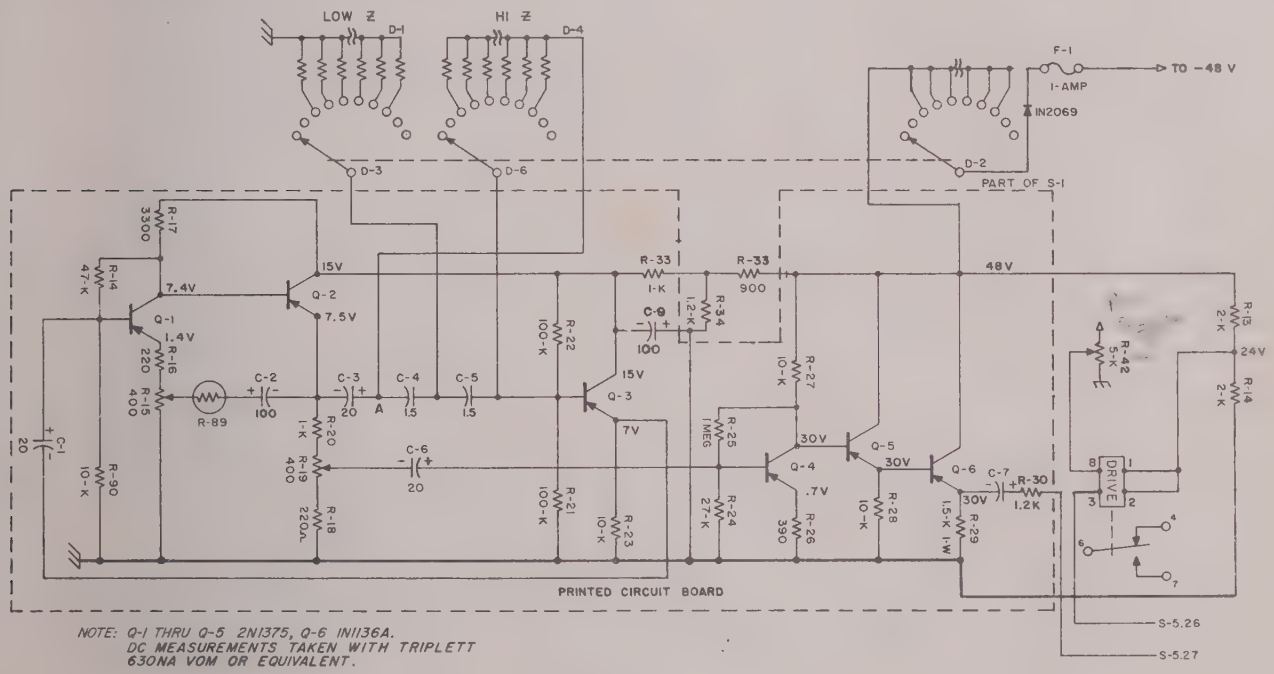


Figure 5-1

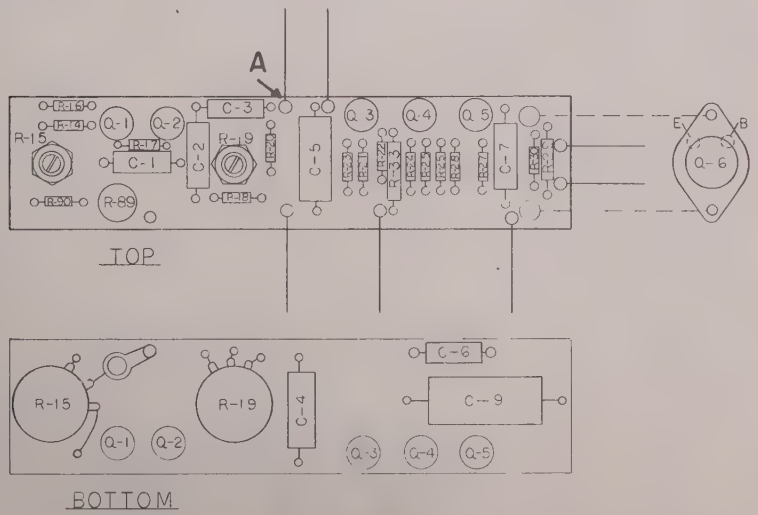


Figure 5-2

SECTION 6

ELECTRONIC PARTS LIST

6.1 INTRODUCTION. The following pages contain the parts list for the Model TTS 26B Pulse Signaling Test Set.

6.2 FSCM Code Numbers, this is the Federal Supply Code of Manufacturers as issued October 1969. A list of codes and their respective manufacturers is given below.

LIST OF MANUFACTURERS

Code No.	Manufacturer
00656	Aerovox Corp, New Bedford, Mass. 02745
01121	Allen Bradley, Milwaukee, Wis. 53204
01295	Texas Instrument Inc. Dallas, Texas 75231
06486	IRC Div. of TRW , Lynn, Mass. 01905
09653	IEI, Brooklyn, N.Y.
12065	Transitron Electric Corp., Boston, Mass. 02128
12697	Clarostat Mfg., Dover, N.H. 03820
13606	Sprague Electric Co., Concord, N.H. 03301
25712	Esse Co., Chicago, Ill. 60629
49671	RCA Corp., New York, N.Y. 10020
71590	Centralab, Milwaukee, Wis. 53201
73869	Herzog Minature Lamp Work Inc., N.Y., N.Y.
75915	Littelfuse Inc. Des Planes, Ill. 60016
76854	Oak Mfg. Co., Crystal Lake, Ill. 60014
77342	Potter-Brumfield Sales Co, Chicago, Ill.
78277	Sigma Instruments , So. Braintree, Mass. 02185
78957	Stromberg-Carlson Corp., Charlotsville, Va. 22902
80368	Sylvania Electric Inc. N.Y., N.Y. 10017
81095	Triad Transformer Corp., Venice, Calif. 90293
82389	Switchcraft Inc. Chicago, Ill. 60630

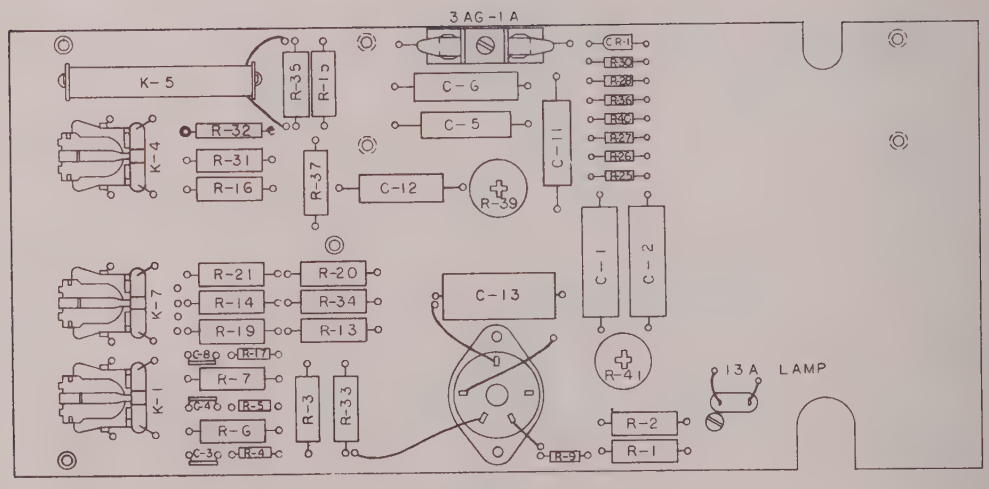


Figure 6-1 Component Location E95075

PC Board E95075

Ref Desig	Description	Manufacturer (FSCM Code No.)	Part Number
R1 and R2	R: 500, 10%, 3W	06486	PW3
R3	R: 1.2K, 10%, 3W	06486	PW3
R4 and R5	R: 220, 10%, ½W	01121	EB
R6	R: 1.5K, 10%, 3W	06486	PW3
R7	R: 2.7K, 10%	06486	PW3
R9	R: 10K, 10%, ½W	01121	EB
R15	R: 100, 10%, 3W	06486	PW3
R16	R: 20K, 10%, 3W	06486	PW3
R17	R: 1K, 10%, ½W	01121	EB
R19	R: 1K, 10%, 3W	06486	PW3
R21	R: 2K, 10%, 3W	06486	PW3
R25	R: 4.7K, 5%, ½W	01121	EB
R26	R: 22K, 10%, ½W	01121	EB
R27	R: 9.1K, 5%, ½W	01121	EB
R28	R: 4.7K, 5%, ½W	01121	EB
R30	R: 7.5K, 5%, ½W	01121	EB
R31	R: 2K, 10%, 3W	06486	PW3
R32	R: 100, 5%, 5W	13606	243E1015
R33	R: 900, 10%, 3W	06486	PW3
R34	R: 1.2K, 10%, 3W	06486	PW3
R35	R: 750, 10%, 5W	06486	PW5
R36	R: 100, 10%, ½W	01121	EB
R39	R: 5K, 10%, 3W	25712	5135
R41	R: 500, 20%, 3W	25712	1106
C1 and C2	C: 2μF, 10%	13606	121P20591R5S2
C3 and C4	C: 0.1μF, 30%, 75V dc	71590	DDA104
C5	C: 10μF, 50V dc	13606	TE1304
C6	C: 5μF, 50V dc	13606	TE1303
C8	C: 0.2μF, 20%, 600V dc	71590	DDA104
C11	C: 10μF, 50V dc	13606	TE1304
C12	C: 1.5μF, 10%, 50V dc	00656	P123ZN
C13	C: 1000μF, 6V dc	09653	APD122
CR1	Diode, Si	12065	1N4003
K4	Relay SPST	77342	RS5D-24 6044-00-300
K5	Relay, A type	12697	CRZ-1056T
DS1	Lamp	80368	GB-13A
F1	Fuse	75915	

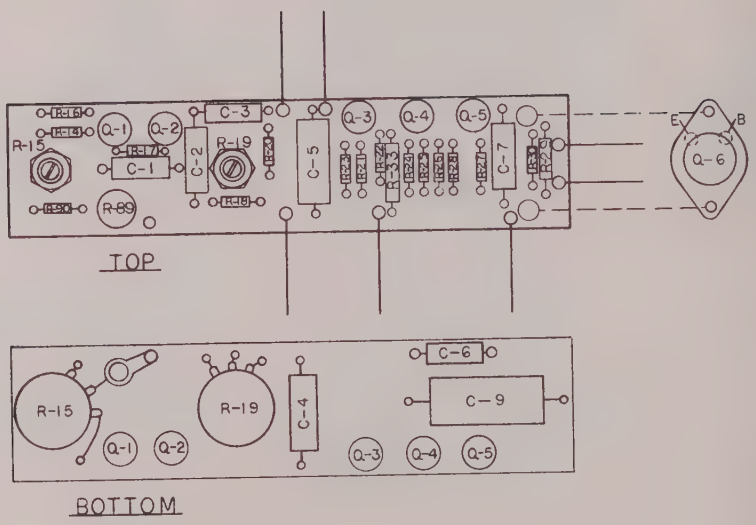


Figure 6-2 Component Location E95026

PC Board E95026

Ref Desig	Description	Manufacturer (FSCM Code No.)	Part Number
R14	R: 47K, 10%, ½W	01121	EB
R15	R: 400, 10%, 2W	12697	CM22425NP
R16	R: 220, 10%, ½W	01121	EB
R17	R: 3.3K, 5%, ½W	01121	EB
R18	R: 220, 10%, ½W	01121	EB
R19	R: 400, 10%, 2W	12697	CM22425NP
R20	R: 1K, 10%, ½W	01121	EB
R21 and R22	R: 100K, 10%, ½W	01121	EB
R23	R: 10K, 10%, ½W	01121	EB
R24	R: 27K, 10%, ½W	01121	EB
R25	R: 1M, 10%, ½W	01121	EB
R26	R: 390, 10%, ½W	01121	EB
R29	R: 1.5K, 10%, 1W	01121	GB
R30	R: 1.3K, 10%, ½W	01121	EB
R33	R: 1K, 10%, 1W	01121	GB
R89	Lamp (screw base)	73869	NEC100
R90	R: 10K, 10%, ½W	01121	EB
C1	C: 20μF, 25V dc	09653	APD046
C2	C: 100μF, 20V dc	09653	APD 095
C3 and C6	C: 20μF, 25V dc	09653	APD046
C4 thru C65	C: 1.5μF, 50V dc	00656	P123ZN
C7	C: 20μF, 50V dc	13606	TE1305
Q1 thru Q5	Transistor, Si	01295	2N1375
Q6	Transistor, Si	49671	2N1136A

Jack Block Assembly

Ref Desig	Description	Manufacturer (FSCM Code No.)	Part Number
R54	R: 220, 10%, $\frac{1}{4}$W	01121	CB
C3 and C4	C: 0.1μF, 30%, 75V dc	71590	DDA104
S6	Turnbutton switch	82389	9S-1097
S7	Turnbutton switch	82389	12061
J1	Telephone type jack	82389	5J-1192
J2	Telephone type jack	82389	5J-1194
J3 and J4	Telephone type jack	82389	5J-1329
J5 and J6	Telephone type jack	82389	5J-1194
J7	Telephone type jack	82389	5J-1192
J8 thru J11	Telephone type jack	82389	5J-1329
J12	Telephone type jack	82389	5J-1334
J13	Telephone type jack	82389	5J-1192

Front Panel Assembly

Ref Desig	Description	Manufacturer (FSCM Code No.)	Part Number
R19 and R24	R: 1K, 10%, 3W	06486	PW3
R32	R: 100, 5%, 5W	13606	243E1015
R36	R: 100, 10%, 3W	06486	PW3
C3, C4, C6	C: 20μF, 25V	09653	
S5	Key switch 2D4C-4C	78957	173D
S10	Key switch 2C-2C	78957	173N
L1	Inductor 6H	81095	C-6X
L5	Inductor 4H	81095	C-4X
K2	Relay 1-C type	78277	12000LG-Sil
K6	Polar relay 1-C type	78277	72A0Z-1000TS-Sil

Switch Assembly

Ref Desig	Description	Manufacturer (FSCM Code No.)	Part Number
R43	R: 1K, 10%, $\frac{1}{2}$W	01121	EB
S1	9 position rotary	76854	266207-K6
S2	5 position rotary	76854	266213-K6
S3	6 position rotary	76854	269722-F7
S4	6 position rotary	76854	266209-J3C
S8	4 position rotary	76854	266210-K6
S9	6 position rotary	76854	269720-J4C

NORTHEAST ELECTRONICS CORPORATION
Airport Road
Concord, New Hampshire

ADDENDUM #1

MODEL TTS 26BCD PULSE SIGNALING TEST SET

This addendum covers the description, operating instructions, schematic, and table of replacement parts for the Model TTS 26BCD Pulse Signaling Test Set.

General

The Model TTS 26BCD may be operated from either a 24 volt or 48 volt DC power supply and features a TTS 26BXD Dial Adapter Accessory Cover as standard equipment.

The unit is otherwise identical in description and operation to the Model TTS 26B.

A description of the Model TTS 26B is given in Section 1.0 of the Operating Instructions.

Performance and Specifications

Same as Section 2.0, except for a large current drain (approximately 500 ma) when operating at 24 volts DC.

Controls and Jacks

Same as Section 3.0, except power supply jacks are designated 24V or 48V.

Circuit Description

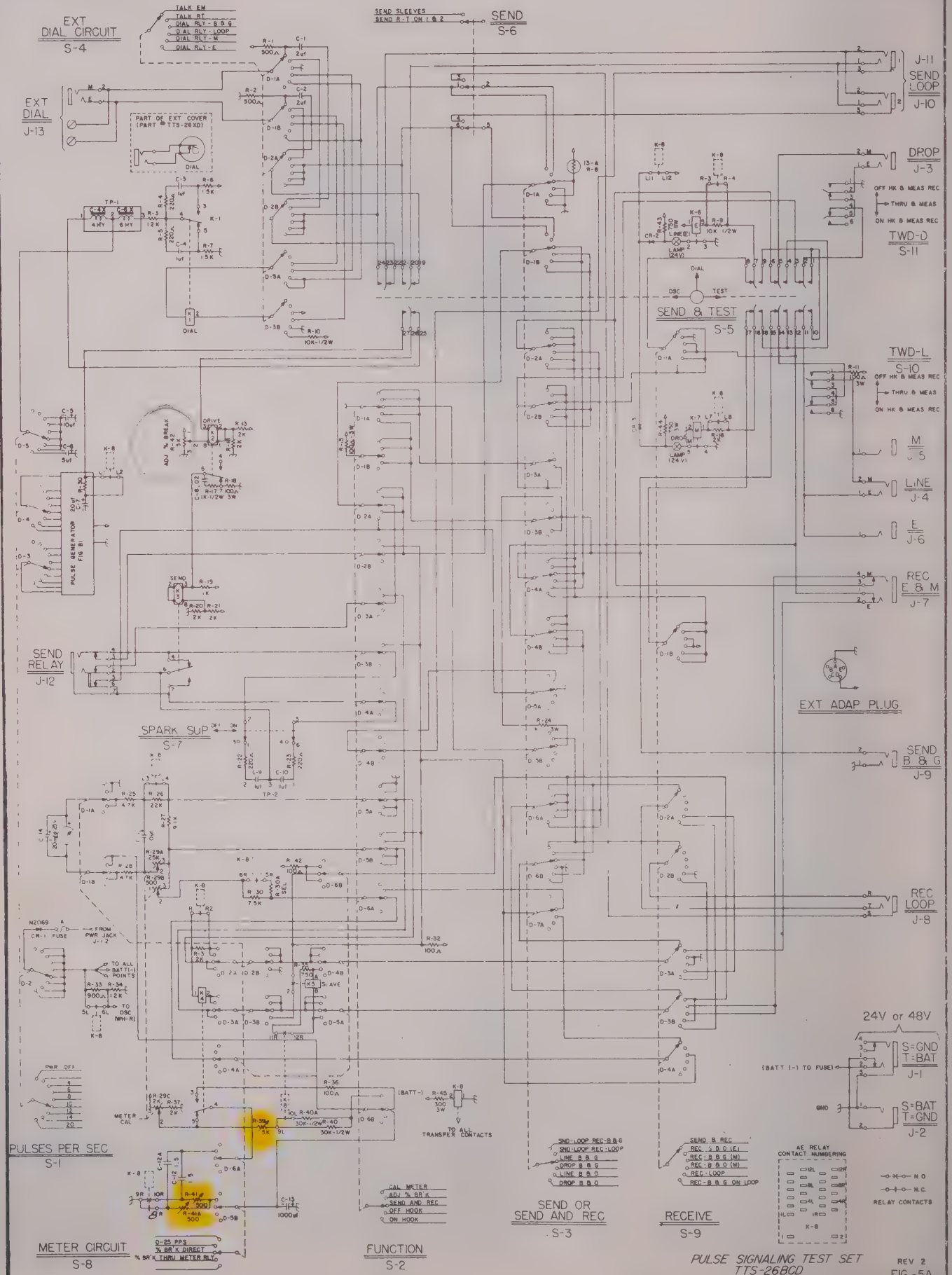
With the exception of the 24 to 48 volt change-over circuitry, the operation of the Model TTS 26BCD is the same as described in Section 4.0.

All of the switching to perform the 24 to 48 volt change-over is accomplished over contacts of relay K8. Relay K8, when released, establishes the proper circuit conditions for 24 volt operation and, when operated, establishes the proper circuit conditions for 48 volt operation.

When the unit is operated from a 24 volt power source, relay K8 remains released. Thus, internal circuits are arranged for 24 volt operation. When 48 volt power is applied to the unit, relay K8 operates and establishes the proper circuit conditions for 48 volt operation.

The voltage required to operate relay K8 is in the order of 35 volts, but the set must be operated over 48 volts for proper calibration. At 24 volt operation the set may be calibrated between 20 and 28 volts.

(over)


EXT DIAL CIRCUIT S-4
EXT DIAL J-13
SEND S-6
J-11 SEND LOOP J-10
DROP J-3
TWD-D S-11
SEND & TEST S-5
TWD-L S-10
M J-5
LINE J-4
E J-6
REC E & M J-7
EXT ADAP PLUG
SEND B & G J-9
REC LOOP J-8
SEND RELAY J-12
SPARK SUP S-7
PULSE GENERATOR FIG 81
PULSES PER SEC S-1
METER CIRCUIT S-8
FUNCTION S-2
SEND OR SEND AND REC S-3
RECEIVE S-9
24V or 48V
S=GND T=BAT J-1
S=BAT T=GND J-2
AE RELAY CONTACT NUMBERING
RELAY CONTACTS
PULSE SIGNALING TEST SET TTS-26BCD
REV 2
FIG-5A

Relay K8 and its associated circuitry are shown in the overall schematic diagram, Figure 5A, opposite.

Operating Procedures

Same as Section 5.0, except that either 24 or 48 volts may be connected to the power input jacks. When operating on 24 volts, only 24 volt signals may be received and measured.

Table of Replacement Parts

For Circuits Involving 24 Volt Operation

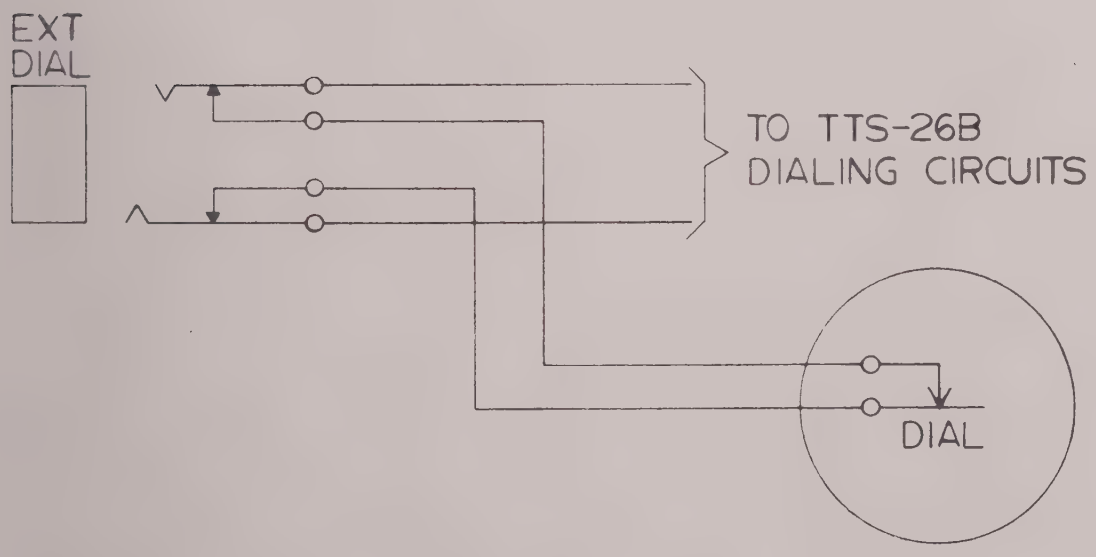
Circuit Ref	Description	Mfr & Mfr's Designation
C12A	Capacitor: fixed, paper, 1.5 mfd, 50 vdc	A, P1232N
R40A	Resistor: fixed, composition, 30K ±10%, ½w	B
R41A	Resistor: variable, wirewound, 500 ohms	G, Series 39
R43	Resistor: fixed, composition, 750 ohms ±10%, 3 w	K, PW-3
R44	Resistor: fixed, composition, 750 ohms ±10%, 3 w	K, PW-3
R45	Resistor: fixed, composition, 300 ohms ±10%, 3 w	K, PW-3
K8	Relay: Series EIN - PE - 16307 - B11	Automatic Electric
CR2	Diode: silicon	U, 1N2069
CR3	Diode: silicon	U, 1N2069
LINE(E)	Lamp: 24E	Westinghouse
DROP(M)	Lamp: 24E	Westinghouse

MODEL TTS 26BDR
PULSE SIGNALING TEST SET

ADDENDUM SHEET #2

The Model TTS 26BDR is a relay rack-mounted version of the TTS 26B. With the exception of the Dial, the operation is identical to the TTS 26B. The dial, mounted on the panel, is connected at all times to the dialing circuits and may be used to dial through the set as described in Section 3.0, Operating Instructions.

To use an external dial, proceed as described in the previously mentioned Section. Insertion of a plug in the EXT DIAL jack disconnects the dial on the front panel, enabling the operator to use an external dial of a telephone.



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03301

Model TTS 26BDLR

PULSE SIGNALING TEST SET

ADDENDUM #3

The Model TTS 26BDLR is a rack mounted version of the TTS 26B and incorporates the additional features of dial and loop-leak circuits. See figure 1 for a schematic of the additional circuitry. The dial is connected in parallel with the EXT DIAL jack and is inserted into the jack.

The loop and leak functions are normally not connected to any other circuits in the unit. To use these functions, connect a line to the TO LINE jack and patch the TO TTS 26 jack to the other jacks on the unit in accordance with the operating instructions in Section 3 of this manual.

The LEAK and LOOP RESISTANCE switches place networks in parallel and series respectively. with the line. With the LEAK switch in the NORMAL position, and the 0/ADD/1000 switch in ADD the LOOP RESISTANCE switch selects one of nine indicated resistances. In the 130V position, a high resistance is selected. With the LEAK switch in the A or B position and the 0/ADD/1000 switch in the ADD position, a network is placed in parallel with the line and any resistance selected by the LOOP RESISTANCE switch is also placed in series. When the LEAK switch is in the C or D position, the LOOP RESISTANCE switch has no effect and the series resistance is controlled by the 0/ADD/1000 switch. The 0 and ADD positions are the same.

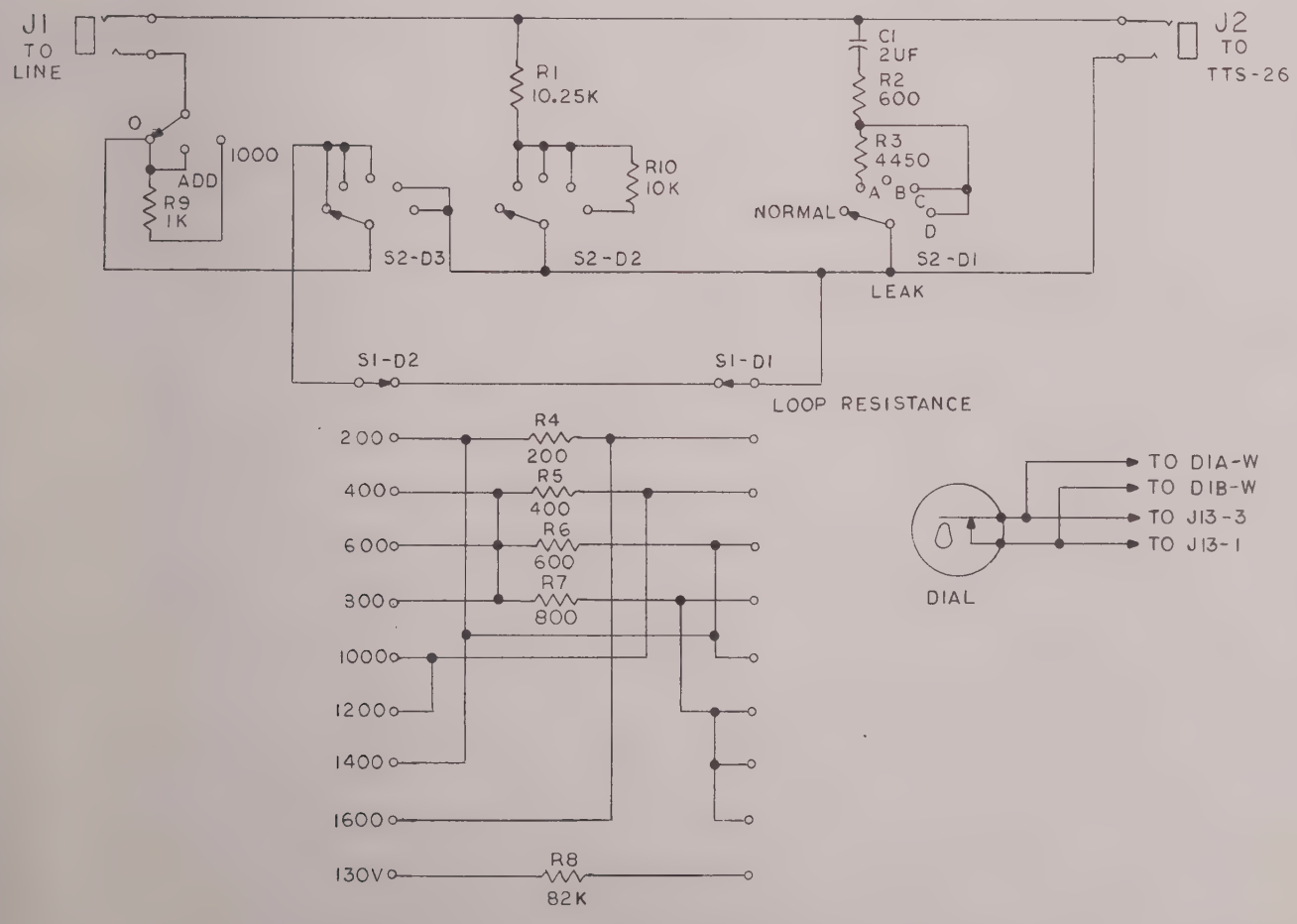


Figure 1-1. Schematic Diagram TTS 26BDLR

ELECTRONIC PARTS LIST

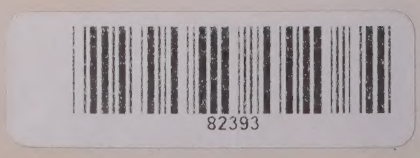
Ref Desig.	Description	Manufacturer FSCM CODE No.	Part Number
R1	R: 10.25K, 1%, 1W	09353	DCF
R2	R: 600, 1%, 5W	19701	MF5C
R3	R: 4.45K, 1%, 5W	19701	MF7C
R4	R: 200, 1%, 5W	09353	ASC15
R5	R: 400, 1%, 7W	94322	EL7
R6	R: 600, 1%, 5W	94322	EL5
R7	R: 800, 1%, 5W	94322	EL5
R8	R: 82K, 5%, 5W	01121	EB
R9	R: 1K, 1%, 5W	94322	EL5
C1	C: 2μF, 200V	27735	D-2.0-200-10
S1	Switch	76854	269430-F2
S2	Switch	78654	269261-F3
S3	Switch	04009	81021-AT
J1 and J2	Jack	82389	L12B

LIST OF MANUFACTURERS

Code No.	Manufacturer
04009	Arrow - Hart - Hegeman, Hartford, Conn. 06106
19701	Electra/Midlands, Mineral Wells, Texas 76067
27735	F-DYNE Electric Co., Fairfield, Conn. 06430
94322	Tellabs Inc., Manchester, N.H. 03102

ERRATA

On page 2-1, POWER REQUIREMENTS, change 220mA to 750mA and at end of paragraph add: 1A feeder circuit required.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